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ABSTRACT

Designed for use with high school juniors, this agribusiness curriculum for city schools contains thirty-two units of instruction in the areas of horticulture and agricultural mechanics. Among the units included in the curriculum are (1) Planting Media, (2) Fertilizer, (3) Plant Classification, (4) Turf Grass Management, (5) Landscape Design, (6) Fundamentals of Electricity, (7) Engine Operation, (8) Position Welding, and (9) Plumbing. Each instructional unit includes objectives, suggested activities, information sheets, assignment sheets, job sheets, transparency masters, a test, and answers to the test. (LRA)

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ED190830

Nebraska Vocational Agribusiness
for City Schools

HORTICULTURE
AGRICULTURE MECHANICS

A Curriculum Guide
11th Grade

Prepared by
THE DEVELOPMENT OF CURRICULUM MODIFICATIONS FOR
URBAN VOCATIONAL AGRIBUSINESS PROGRAMS IN NEBRASKA
Department of Agricultural Education
Institute of Agriculture and Natural Resources
The University of Nebraska-Lincoln
Lincoln, Nebraska
Dr. Allen G. Blezek, Director
William L. Umbaugh, Curriculum Specialist
1980

CE 026 336

For Support Through Authorization of the
Nebraska State Board for Vocational Education
Under the Provisions of Sub-Part 3
Of Vocational Education Amendments of 1976

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
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Unit V Engine Operation Part I AM-143-B

Unit VI Engine Operation Part II AM-179-B

Unit VII Servicing Small Engines AM-217-B

Unit VIII Trouble Shooting of Small Engines AM-261-B

Unit IX Oxyacetylene Braze Welding AM-289-B

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Appreciation is expressed to the many individuals who gave their time, effort, and expertise to make this publication possible. Appreciation goes to the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, Stillwater, Oklahoma, for permission to modify selected Vocational Agriculture Basic Core Curriculum materials for use in Nebraska.

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Finally much appreciation goes to William Umbaugh for this project whose untiring efforts have assured its completion.

Allen Blezek *Director*
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Curriculum For City Schools

INTRODUCTION

Vocational education in agriculture has changed. Fewer students each year are returning to the farm and more are entering fields of related agriculture occupations. Teachers of vocational agriculture are faced with the problem of teaching subject matter areas in which they have limited experience and little or no available instructional materials. This has created a challenge for curriculum personnel. The Nebraska Vocational Agriculture Curriculum Project was designed to accept this challenge.

Units of instruction have been developed for Vocational Agriculture to cover eight sections: Career Orientation, Basic Skills of Agribusiness, Horticulture, Agricultural Processing, Production Agriculture, Companion Animals, Natural Resources, and Agricultural Mechanics. The instructional units are designed to account for seventy percent of an instructor's time in teaching vocational agriculture. The remaining thirty percent is left to the individual instructor according to the demands of the local community.

USE OF THIS PUBLICATION

The approach taken in this publication will be unique and quite new to some educators. Teachers, before attempting to teach from this material, should become familiar with it and should understand the *writer's* ideas. This introduction is for the teacher's benefit and explains the most effective use of the publication.

Instructional Units

Each instructional unit includes objectives, suggested activities, information sheets, assignment sheets, job sheets, transparency masters, a test, and answers to the test.

Objectives (White)

Included in each unit of instruction are measurable objectives. These objectives state the goals of the course in such a way that both teacher and student will know the changes in behavior expected to occur as a result of the instruction. In short, objectives are a means of providing a sense of direction and accomplishment for the student.

The measurable objectives are stated in two forms: Unit Objectives stating the subject matter to be covered in a unit of instruction; Specific Objectives stating the performance of the student in order to reach the unit objective. Specific objectives are most important in regard to teaching the unit. Before attempting to teach a unit, unit and specific objectives must be explained to the student in order to tell him what is expected.

Suggested Activities (White)

Each unit of instruction has a Suggested Activities Sheet outlining steps to follow in accomplishing the specific objectives. The activities relate the duties of the instructor to the particular unit. Duties may vary according to the unit and usually include the following: provide students with information sheet and job sheets, make transparencies, discuss unit and specific objectives, discuss information sheet, and give test. Teachers are encouraged to use any additional activities and means of accomplishing objectives.

Information Sheets (Green)

The information sheets contain essential facts necessary for the teaching of a unit of instruction. These sheets should be given to the student. Information sheets can be reproduced at the local school.

Assignment Sheets (Buff)

Assignment sheets are included in units when necessary. An assignment sheet allows the student to practice a writeen skill, such as calculating board feet, before the evaluation is given.

Job Sheets (Blue)

Job sheets are included in units when necessary. A job sheet gives operations necessary to successfully complete a production job. It contains the name of the job, drawings, materials and tools needed, and procedures for completing a job.

Transparency Masters (White)

Transparency masters are charts, pictures, or illustrations printed for use in making overhead transparencies. These are included in units when necessary. A transparency should be made from the transparency master and be shown on an overhead projector to supplement the information.

Test (Yellow)

A test is included at the close of each unit of instruction to measure the specific objectives.

Page Numbering System

Each section in this publication is assigned a specific letter: (A) Plant and Soil Science; (B) Animal Science; (C) Supervised Agricultural Training and Agricultural Business Management; (D) Leadership; (E) Career Selection; (F) Agricultural Mechanics. Pages are numbered consecutively within each section. For example, Career Selection begins with 1-E. If the page is available as a transparency master, TM appears at the bottom of the page.

The following key will help to easily identify each section by color:

White – Objectives, Suggested Activities, Transparency Masters
Green – Information Sheets
Blue – Job Sheets
Buff – Assignment Sheets
Yellow – Test
Pink – Answers to Test

(NOTE: This publication will provide unity of instruction throughout Nebraska in teaching vocational agriculture. The effectiveness of this publication will depend on you as an instructor.)

FOREWORD

This publication is designed to provide basic instruction in Agriculture/Agribusiness (Vocational Agriculture) Education in Nebraska's City Schools.

The problem of what to teach, the resource aids available, and the choices, are problems facing today's Vocational Agriculture/Agribusiness Instructors. This curriculum publication is designed to assist in improving the instructional process and results. In its preparation for use, it has involved many of those who will use the material.

Its purpose is ultimately intended to more adequately prepare the student with knowledge, understanding, and ability in a chosen field.

Appreciation is expressed for the time and effort of the many individuals and groups who assisted in the development of this publication. It is our hope that you may be a more effective teacher through the use of this core curriculum.

M. Anne Campbell
Nebraska Commissioner of Education

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STUDY OF SOILS
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to select from a list reasons that soils are important. The student should be able to discuss soil formation and label layers of a soil profile. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with soils to the correct definitions.
2. Select from a list reasons that soils are important.
3. Discuss three factors that affect soil formation.
4. List five benefits of organic matter.
5. Identify three soil particles according to size.
6. Label an illustration showing the different layers of a soil profile.
7. Identify five kinds of soil structures.
8. Match colors of soils with the identifying characteristics of each.
9. Label a drawing showing the composition of an average soil.
10. Match terms indicating degree of erosion to the correct descriptions.
11. Match terms indicating soil depth to the correct descriptions.
12. Match terms indicating degrees of permeability to the correct descriptions.
13. Match terms indicating degrees of slope to the correct descriptions.

STUDY OF SOILS
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Conduct field trip to study soils.

   G. Give test.

II. Student:

   A. Read objectives.

   B. Study information sheet and take notes.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheets

   C. Transparency masters

      1. TM 1—Types of Physical Weathering

      2. TM 2—Soil Particles

      3. TM 3—Soil Profile

      4. TM 4—Soil Structure

      5. TM 5—Composition of Average Soil

   D. Test

   E. Answers to test

II. References:

A. *Instructional Materials for Vocational Agriculture I.* College Station, Texas: Teaching Materials Center, Agricultural Education Department, Texas A&M University.

B. Millar, Charles Earnest, Lloyd M. Turk, and H. D. Foth. *Fundamentals of Soil Science.* New York: John Wiley and Sons, Inc.

C. Berger, Kermit C. *Introductory Soils.* New York: The MacMillan Company.

D. Donahue, Roy L. *Our Soils and Their Management.* Danville, Illinois: The Interstate Printers and Publishers, Inc.

E. *Plant Science.* Columbia, Missouri: State Department of Education, Agricultural Education Section, University of Missouri.

F. *Soil Structure.* Urbana, Illinois: Vocational Agriculture Service, University of Illinois.

G *Soil Color.* Urbana, Illinois: Vocational Agriculture Service, University of Illinois.

H. *Land Judging.* Bulletin Number E.C. 5-36-68. Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, Lincoln, Nebraska.

I. *NebGuides.* Lincoln, Nebraska: Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, Lincoln, Neraska.

STUDY OF SOILS
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Soil—Outer layer of the earth's crust capable of supporting plant growth; made up of mineral and organic matter

B. Organic matter—General term for plant and animal material in or on the soil in all stages of decomposition

(NOTE: in chemistry, *organic* refers to the compounds of carbons.)

C. Mineral—General term for the inorganic elements in the soil

Examples: Nitrogen, potash, phosphorus

D. Soil profile—Cross section of a soil from top to bottom (Transparency 3)

E. Soil texture—Size of the individual soil particles such as sand, silt, and clay

F. Soil color—Indication of the amount of organic matter, moisture, and texture of the soil

(NOTE: Kinds of compounds contained in the soil, such as iron ($Fe_2 O_3$), will also give a characteristic color.)

G. Soil structure—Way in which individual soil particles are grouped together to form clusters of particles (Transparency 4)

H. Rock weathering—Process by which rocks are broken down into soil-sized particles through exposure to the weather over hundreds of years

I. Leaching—Removal of soil components from the soil by the downward action of water

J. Rock—More or less consolidated mass composed of two or more minerals

K. Aggregate—Single mass or cluster of soil particles such as a clod, crumb, or granule

L. Slope—Number of feet fall in each 100 feet of distance

M. Permeability—Ease of movement of air and water through the soil

N. Depth—Total thickness of soil from the topsoil to the parent material

INFORMATION SHEET

II. Importance of soils

  A. Provide food

  B. Provide energy

  C. Provide shelter

III. Factors affecting soil formation

  A. Parent materials

    1. Rocks

      a. Igneous—Derived from the molten materials in the center of the earth's crust

      b. Metamorphic—Formed from the pre-existing rocks through the action of extreme heat and great pressures

      c. Sedimentary—Deposited by rivers, moving glaciers, or wind

    2. Moved by

      a. Wind

      b. Water

      c. Glaciers

  B. Weathering (Transparency 1)

    1. Physical—Mechanical forces caused by temperature changes, such as heating and cooling, freezing and thawing, which have soil abrasive action

    2. Chemical—Chemical reactions of water, oxygen, and carbon dioxide

  C. Climate

    1. Temperature

    2. Rainfall

  D. Vegetation and organisms

    1. Plant—Lichens, mosses, weeds, grasses, shrubs, trees

    2. Animal—Bacteria, fungi, birds, man

INFORMATION SHEET

E. Slope and drainage
  1. Hillsides
    a. Thin topsoil caused by erosion
    b. Less plant growth
    c. Less organic matter
    d. Less leaching
  2. Flat lands
    a. Deeper topsoil
    b. More vegetation
    c. More organic matter
    d. More leaching

IV. Benefits of organic matter
  A. Makes soil porous
  B. Supplies nitrogen to the plant
  C. Holds water in the soil
  D. Furnishes food for soil organisms
  E. Stores mineral nutrients
  F. Reduces leaching
  G. Stabilizes soil structure

V. Soil particles (Transparency 2)
  A. Sand—Greater than .05 mm
  B. Silt—.002 mm to .05 mm
  C. Clay—Less than .002 mm

VI. Soil profile (Transparency 3)
  A. Topsoil
  B. Subsoil
  C. Parent material

INFORMATION SHEET

VII. Kinds of soil structures (Transparency 4)

- A. Crumb—Very porous granular structure
- B. Granular—Individual grains are grouped into spherical aggregates with indistinct sides
- C. Platy—Aggregate has thin vertical axis and long horizontal axis; flat, tubular
- D. Prismatic—Aggregate is prismlike with vertical axis of the aggregate longer than the horizontal
- E. Blocky—Aggregate has equal sides; may be round or angular
- F. Columnar—Aggregate is columnlike with vertical axis longer than the horizontal

VIII. Soil color

- A. Dark brown to black—Regarded as being the most productive; usually contains a higher organic matter content
- B. Red or reddish brown—Usually less fertile than black or dark brown soils; may contain a high iron content
- C. Yellow—Usually caused by imperfect drainage
- D. Gray—Low in organic matter

IX. Composition of an average soil (Transparency 5)

- A. Mineral matter—48%
- B. Water—25%
- C. Air—25%
- D. Organic matter—2%

X. Degrees of erosion

- A. None to slight—Less than 25 percent of topsoil removed
- B. Moderate—26 to 75 percent of topsoil removed
- C. Severe—76 percent or more of the topsoil lost and up to 25% to all of the subsoil lost
- D. Very severe—76 percent or more of topsoil and from 25% to all of the subsoil lost
- E. Very severely gullied or land destroyed by gullies

INFORMATION SHEET

XI. Soil depths

  A. Deep—More than 36 inches deep

  B. Moderately deep—20 to 36 inches deep

  C. Shallow—10 to 20 inches deep

  D. Very shallow—Less than 10 inches deep

XII. Degrees of permeability

  A. Slow—Heavy to moderately heavy

  B. Moderately Slow—Moderately heavy—medium

  C. Moderate—Moderately light—medium—moderately heavy

  D. Moderately Rapid—Moderately light—light

  E. Rapid—Light—very light

  F. Very Rapid—Very light—coarse sands and gravel

XIII. Degrees of slope*

  A. Nearly level

  B. Gently sloping

  C. Moderately sloping

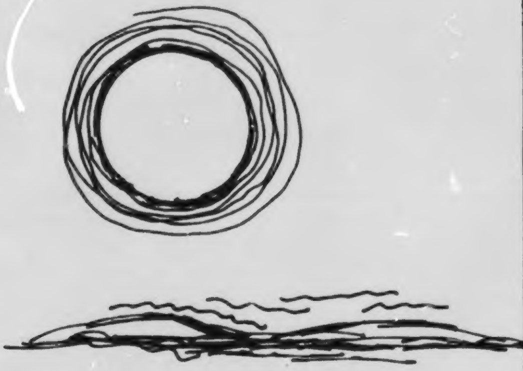
  D. Strongly sloping

  E. Steep

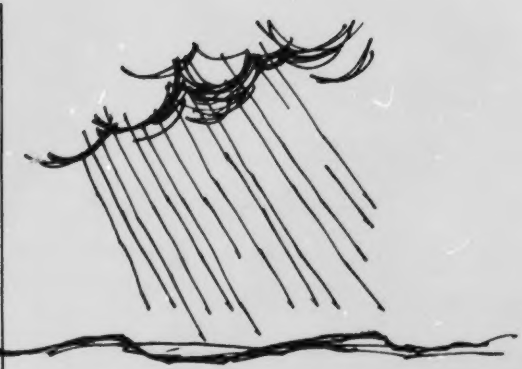
  F. Very steep

  *Slopes for each area to be added in by individual instructor

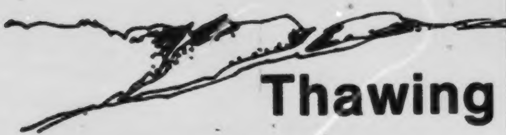
Types of Physical Weathering



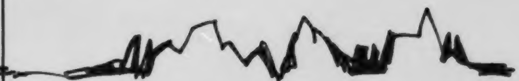
Heating & Cooling



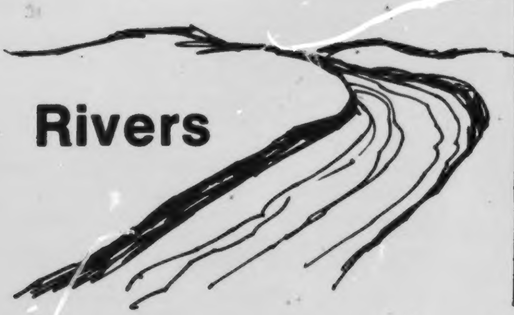
Wetting & Drying



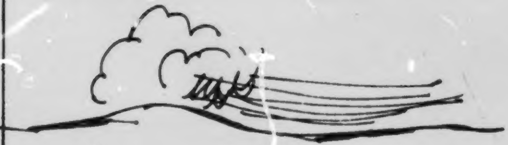
Thawing



Freezing



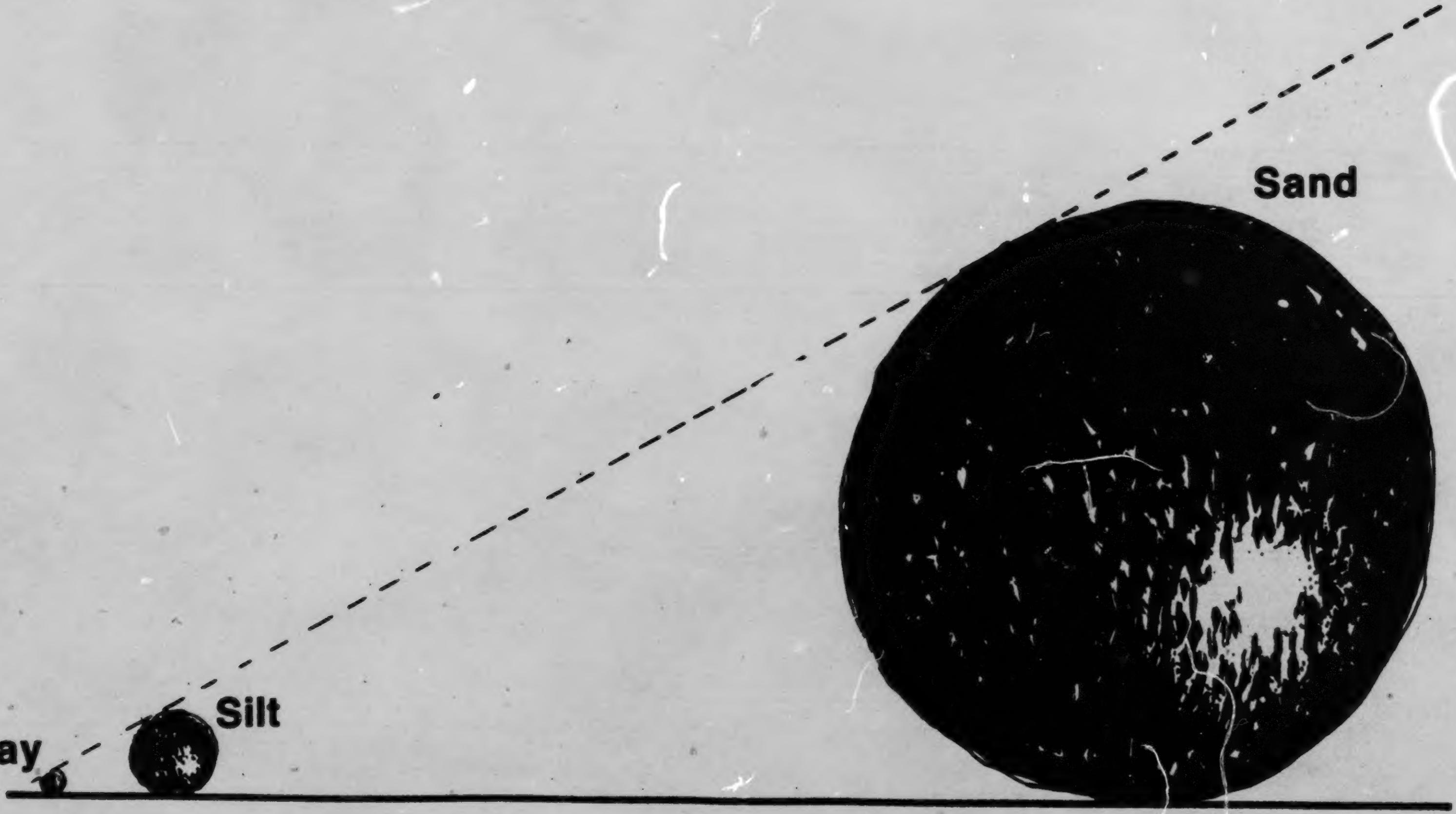
Rivers



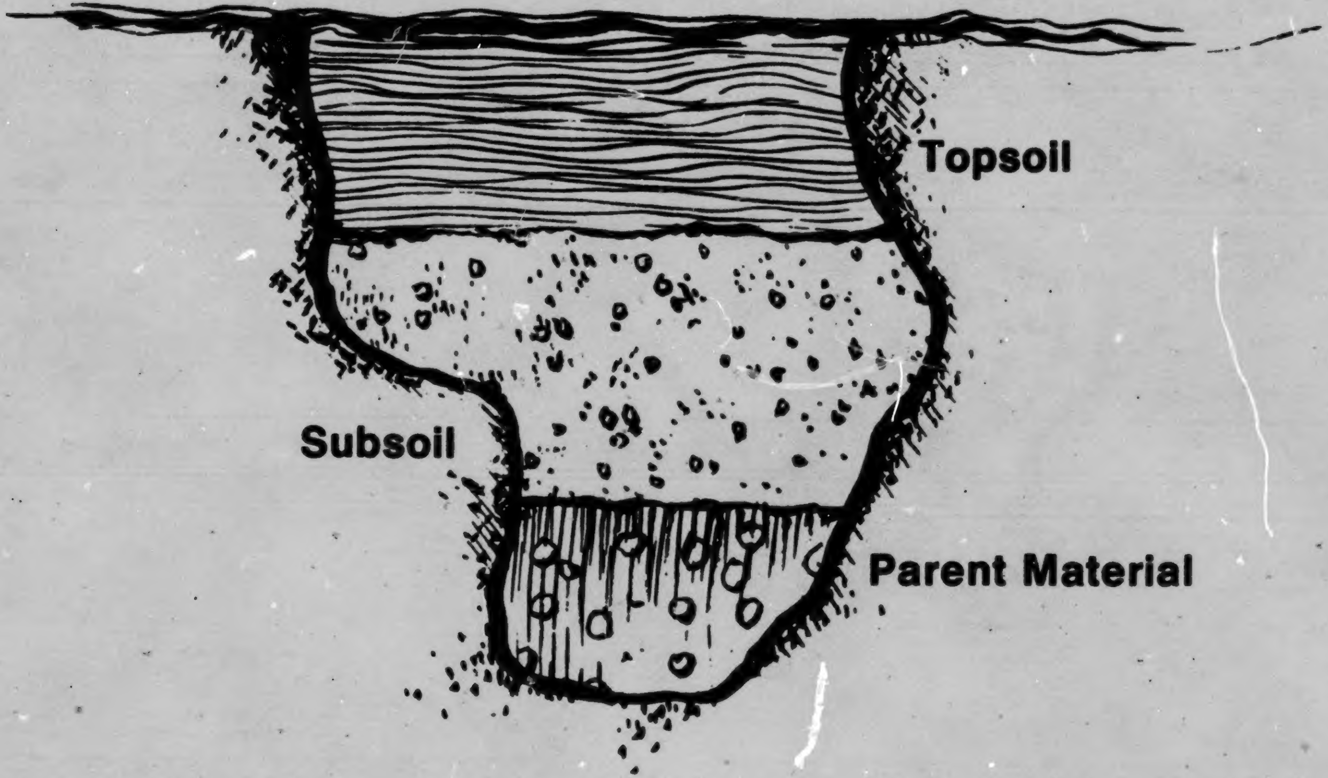
Wind

TM 1

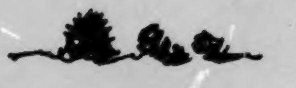
Soil Particles


Sand
Silt
Clay

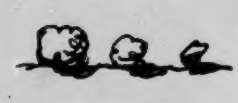
Soil Profile


Topsoil
Subsoil
Parent Material

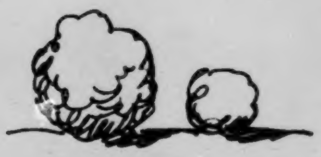
Soil Structure



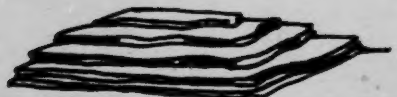
Crumb



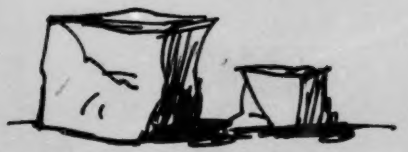
Granular



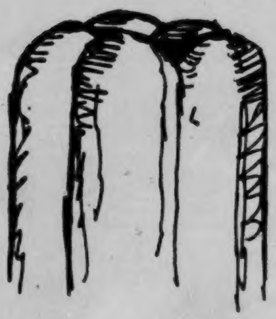
Subangular Blocky



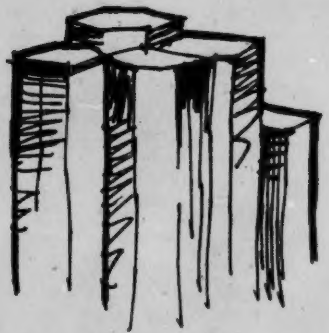
Platy



Angular Blocky



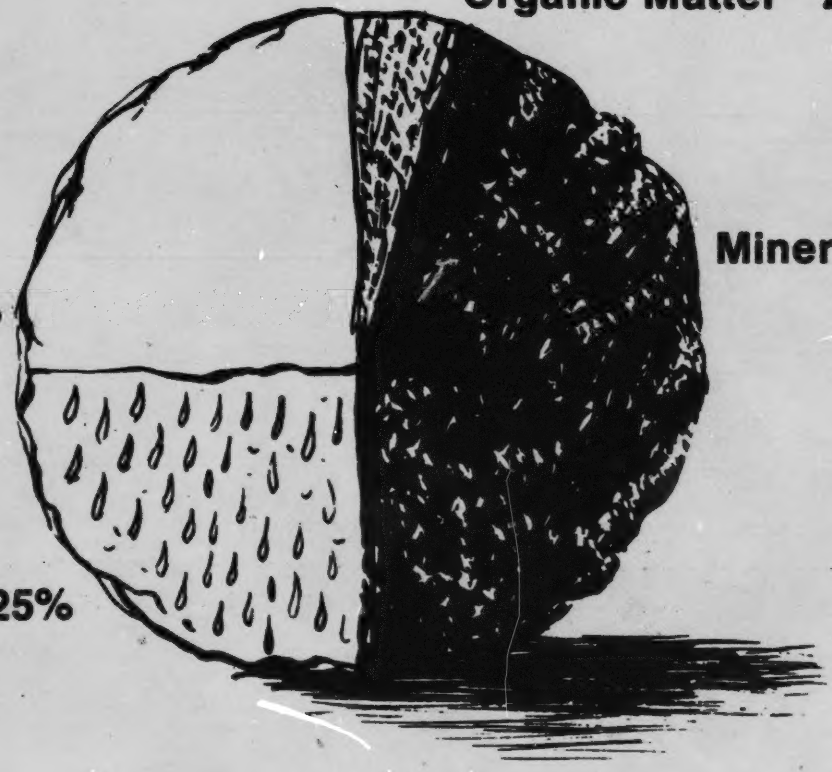
Columnar



Prismatic

TM

Composition of Average Soil



STUDY OF SOILS
UNIT I

TEST

1. Match the terms on the right to the correct definition.

____ a. Way in which individual soil particles are grouped together to form clusters of particles

____ b. Cross section of a soil from top to bottom

____ c. Outer layer of the earth's crust capable of supporting plant growth; made up of mineral and organic matter

____ d. Total thickness of soil from the topsoil to the parent material

____ e. Single mass or cluster of soil particles such as a clod, crumb, or granule

____ f. Removal of soil components from the soil by the downward action of water

____ g. Indication of the amount of organic matter, moisture, and texture of the soil

____ h. General term for the inorganic elements in the soil

____ i. Ease of movement of air and water through the soil

____ j. Number of feet fall in each 100 feet of distance

____ k. General term for plant and animal material in or on the soil in all stages of decomposition

____ l. More or less consolidated mass composed of two or more minerals

____ m. Process by which rocks are broken down into soil-sized particles through exposure to the weather over hundreds of years

____ n. Size of the individual soil particles such as sand, silt, and clay

1. Soil
2. Organic matter
3. Mineral
4. Soil profile
5. Soil texture
6. Soil color
7. Soil structure
8. Rock weathering
9. Leaching
10. Rock
11. Aggregate
12. Slope
13. Permeability
14. Depth

2. Select from the list below reasons that soils are important by placing an "X" in the blanks.

____ a. Holds the earth together

____ b. Provides food

____ c. Provides energy

____ d. Provides a base on which to build houses

____ e. Provides shelter

____ f. Provides insulation

3. Discuss three factors that affect soil formation.

4. List five benefits of organic matter.

a.

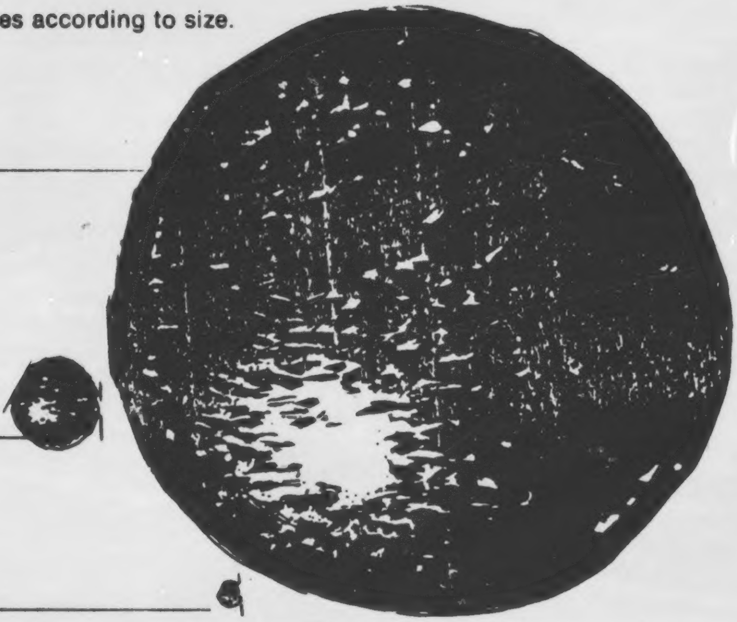
b.

c.

d.

e.

5. Identify three soil particles according to size.

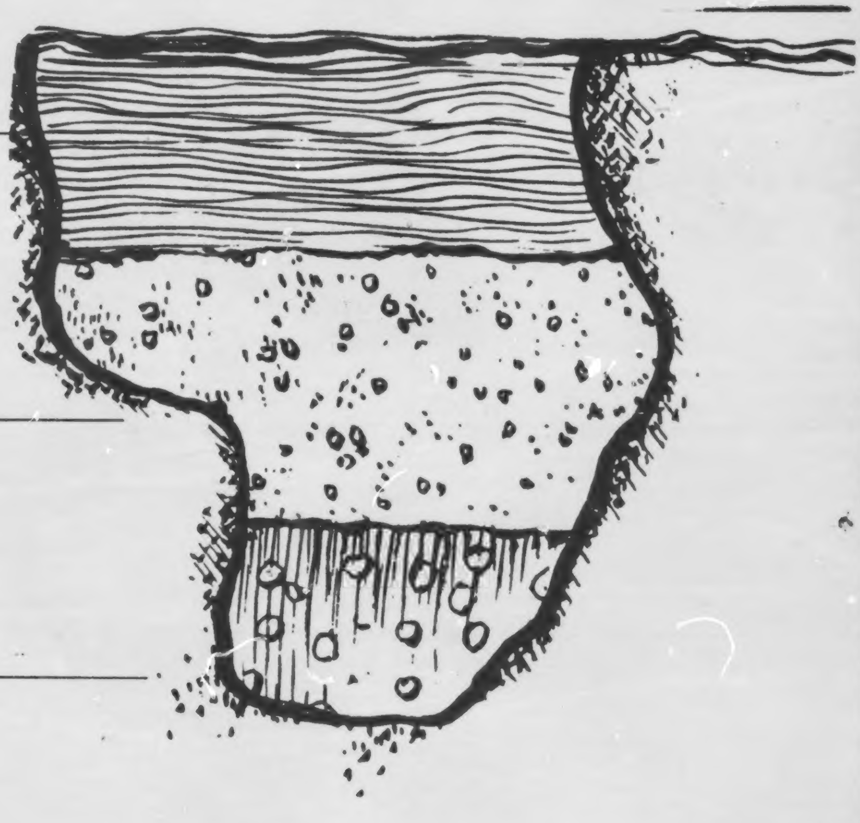


a. ______________________

b. ______________________

c. ______________________

6. Label the drawing below showing the different layers of a soil profile.

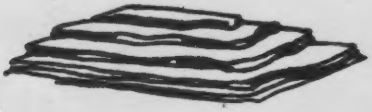


a. ______________________

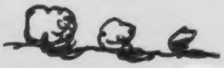
b. ______________________

c. ______________________

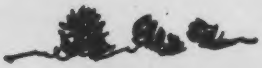
7. Identify five kinds of soil structures.



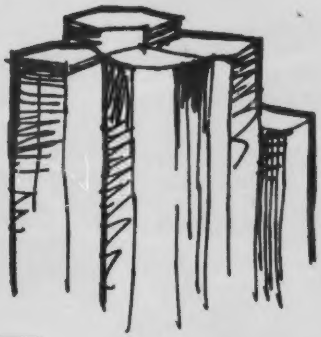
a. ____________________



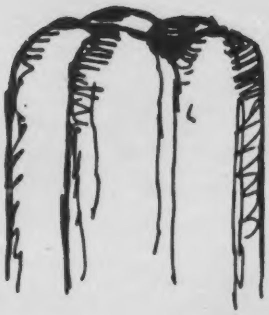
b. ____________________



c. ____________________



d. ____________________



e. ____________________

8. Match the color of soil on the right to the correct characteristic.

____ a. Usually caused by imperfect drainage

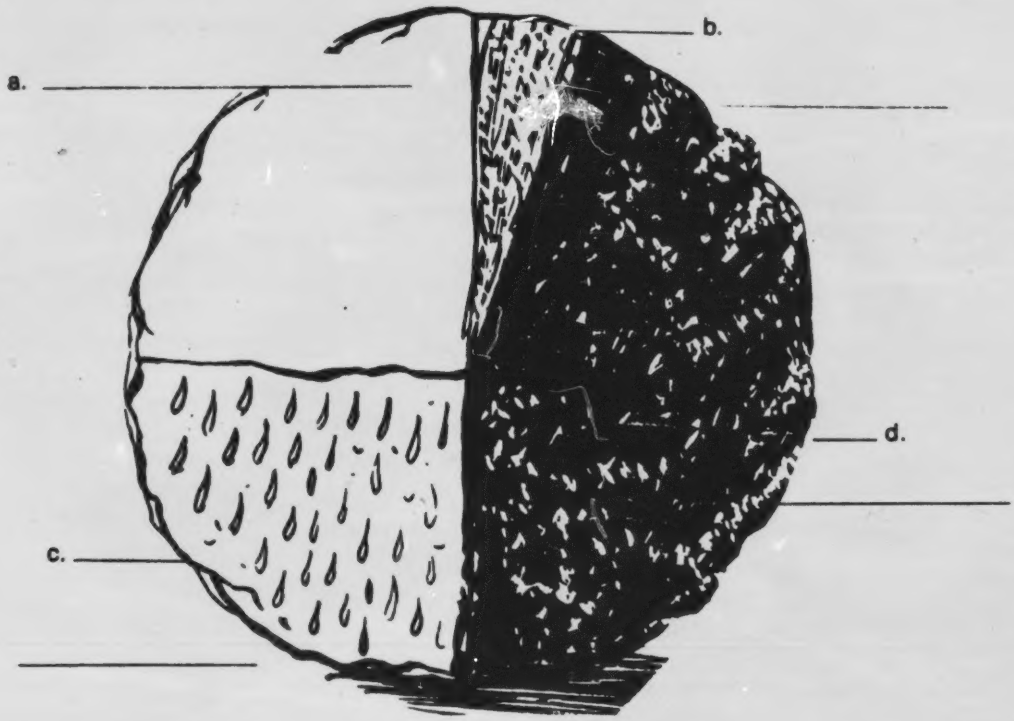
____ b. Low in organic matter

____ c. Regarded as being the most productive; usually contains a higher organic matter content

____ d. Usually less fertile than black or dark brown soils; may contain a high iron content

1. Dark brown to black
2. Red or reddish brown
3. Yellow
4. Gray

9. Label the drawing below showing composition of an average soil.



10. Match the terms indicating degree of erosion on the right to the correct description.

___ a. 76 percent of the topsoil lost to 25% of the subsoil lost

___ b. 76 percent of the topsoil and from 25% to all of the subsoil lost. Very severly gullied or land destroyed by gullies

___ c. 26 to 75% of topsoil removed

___ d. Less than 25% of topsoil removed

1. None to slight
2. Moderate
3. Severe
4. Very severe

11. Match terms indicating soil depth on the right to the correct description.

___ a. More than 36 inches deep

___ b. 20 to 36 inches deep

___ c. 10 to 20 inches deep

___ d. Less than 10 inches deep

1. Deep
2. Moderately deep
3. Shallow
4. Very shallow

12. Match the terms indicating degrees of permeability on the right to the correct description.

____ a.	Soils that have sandy subsoils	1. Very slow
____ b.	Soils that have crumbly, clayey subsoils	2. Slow
____ c.	Moderately light, light subsoils	3. Moderate
____ d.	Soils that have high granular, clay loam subsoils	4. Rapid

13. Match the terms indicating degrees of slope on the right to the correct description.

____ a.	Less than_____foot fall in each 100 feet	1. Nearly level
____ b.	_____to_____feet fall in each 100 feet	2. Gently sloping
____ c.	_____to_____feet fall in each 100 feet	3. Moderately sloping
____ d.	_____to_____feet fall in each 100 feet	4. Strongly sloping
____ e.	_____to_____feet fall in each 100 feet	5. Steep
____ f.	More than_____feet fall in each 100 feet	6. Very steep

*Instructors to fill in blanks with local figures

STUDY OF SOILS
UNIT I

ANSWERS TO TEST

1. a. 7
   b. 4
   c. 1
   d. 14
   e. 11
   f. 9
   g. 6
   h. 3
   i. 13
   j. 12
   k. 2
   l. 10
   m. 8
   n. 5

2. b, c, e

3. Discussion may include any three of the following:

   a. Parent materials

      1) Rocks

         a) Igneous—Derived from the molten materials in the center of the earth's crust

         b) Metamorphic—Formed from the pre-existing rocks through the action of extreme heat and great pressures

         c) Sedimentary—Deposited by rivers, moving glaciers, or wind

      2) Moved by

         a) Wind

         b) Water

         c) Glaciers

   b. Weathering

      1) Physical—Mechanical forces caused by temperature changes, such as heating and cooling, freezing, and thawing, which have soil abrasive action

      2) Chemical—Chemical reactions of water, oxygen, and carbon dioxide

- c. Climate
    - 1) Temperature
    - 2) Rainfall
- d. Vegetation and organism
    - 1) Plant—Lichens, mosses, weeds, grasses, shrubs, trees
    - 2) Animal—Bacteria, fungi, birds, man
- e. Slope and drainage
    - 1) Hillsides
        - a) Thin topsoil caused by erosion
        - b) Less plant growth
        - c) Less organic matter
        - d) Less leaching
    - 2) Flat lands
        - a) Deeper topsoil
        - b) More vegetation
        - c) More organic matter
        - d) More leaching

4. Any five of the following:
    - a. Makes soil porous
    - b. Supplies nitrogen to the plant
    - c. Holds water in the soil
    - d. Furnishes food for soil organisms
    - e. Stores mineral nutrients
    - f. Reduces leaching
    - g. Stabilizes soil structure

5. a. Sand
   b. Silt
   c. Clay
6. a. Topsoil
   b. Subsoil
   c. Parent material
7. a. Platy
   b. Granular
   c. Crumb
   d. Prismatic
   e. Columnar
8. a. 3
   b. 4
   c. 1
   d. 2
9. a. Air
   b. Organic matter
   c. Water
   d. Mineral matter
10. a. 3
    b. 4
    c. 2
    d. 1
11. a. 1
    b. 2
    c. 3
    d. 4

12. a. 4
    b. 2
    c. 1
    d. 3

13. a. 1
    b. 3
    c. 5
    d. 2
    e. 4
    f. 6

PLANTING MEDIA
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to mix ingredients for one cubic yard of planting medium and pasteurize soil. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with planting media to the correct definitions.
2. List five key characteristics describing an ideal planting medium.
3. List three methods of sterilizing media mixtures.
4. List three ingredients used in a basic planting medium.
5. List six chemical ingredients used in basic planting media.
6. Arrange in order the five steps in mixing planting media.
7. Demonstrate the ability to:
    a. Mix the ingredients for one cubic yard of planting medium.
    b. Pasteurize soil.

PLANTING MEDIA
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheets.

  F. Discuss and demonstrate procedures outlined in job sheets.

  G. Give tests.

II. Students:

  A. Read objectives.

  B. Study information sheets.

  C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters
    1. TM 1—Types of Planting Media

    2. TM 2—Proper Mixing of Growing Media

  D. Job sheets
    1. Job Sheet #1—Mix Planting Medium

    2. Job Sheet #2—Pasteurize Soil

  E. Test

  F. Answers to test

II. References—Chandler, Philip A. *The U.C. System for Producing Container Plants.* San Luis Obispo: University of California, Division of Agricultural Sciences; 1968.

PLANTING MEDIA
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Peat moss—Partially decomposed remains of aquatic vegetation which has been preserved under water; has very high water-holding capacity and is a basic ingredient in media mixes

B. Vermiculite—Expanded mineral that has a high water-holding capacity

C. Perlite—Volcanic pumice used in media mixes in place of sand

D. Sand—Small rock grains used as an ingredient in media mixes

E. Sphagnum moss—Dehydrated remains of bog plants; high in water holding capacity

F. Potassium nitrate—Fertilizer material that provides the nutrients potassium and nitrogen

G. Potassium sulphate—Fertilizer material that provides the nutrients potassium and sulphur

H. Single sulpha phosphate—Fertilizer material that provides the nutrient phosphorus

I. Dolomite limestone—Soil amendment that neutralizes the acid in the media and provides the nutrient magnesium

J. Gypsum—Soil amendment that neutralizes the acid in the media and provides the nutrient sulphur

K. Calcium carbonate lime—Soil amendment that consists of powdered limestone that neutralizes acid in soil media

II. Characteristics of an ideal planting medium

A. Porous

B. Dense

C. Sterile

D. Nutritious

E. Lightweight

INFORMATION SHEET

III. Methods of sterilizing media mixtures

  A. Steam

  B. Chemicals

  C. Dry heat

  (NOTE: A temperature of 180° F for 30 minutes will sterilize a medium)

IV. Ingredients used in a basic planting medium (Transparency 1)

  A. Sand

  B. Peat

  C. Perlite

  D. Vermiculite

  E. Sphagnum moss

V. Chemical ingredients used in a basic planting medium

  A. Potassium nitrate

  B. Potassium sulphate

  C. Single sulpha phosphate

  D. Dolomite limestone

  E. Gypsum

  F. Calcium carbonate lime

VI. Procedure for mixing planting media (Transparency 2)

  A. Dampen peat moss 1 to 3 days before mixing

  B. Spread chemical components on top

  C. Start a second pile with materials from the first

  D. Repeat until blended

  E. Mix with machine

TYPES OF MEDIA

SAND

PEAT

SPHAGNUM PEAT

VERMICULITE

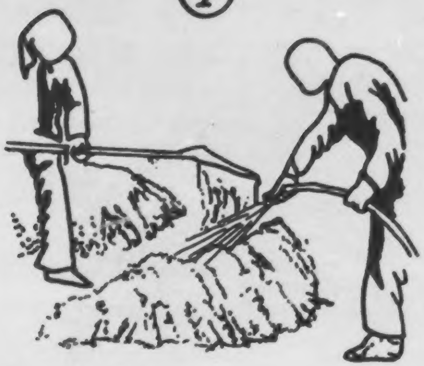
PERLITE

BARK, SAWDUST, & WOOD SHAVINGS

SOIL AMENDMENT

PROPER MIXING OF A GROWING MEDIA

①



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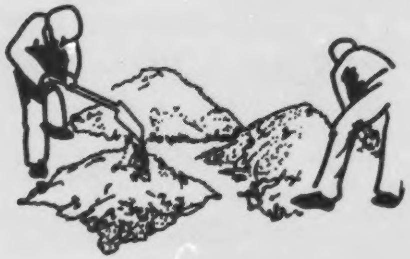

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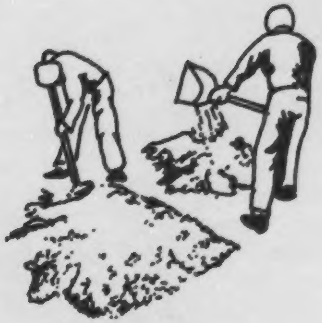

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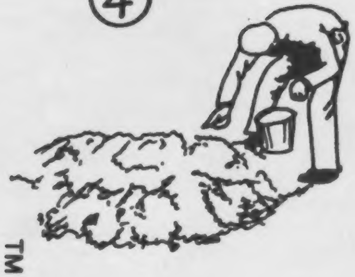

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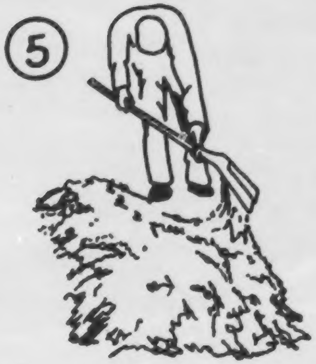

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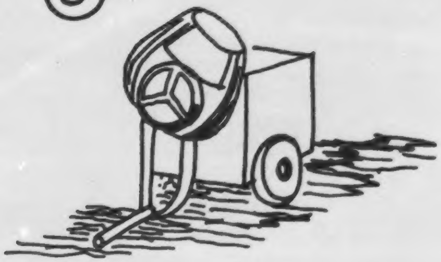


PLANTING MEDIA
UNIT II

Job Sheet #1—MIX PLANTING MEDIUM

I. Materials:

   A. Fine sand

   B. Peat moss

   C. Potassium nitrate

   D. Potassium sulphate

   E. Single super phosphate

   F. Dolomita limestone

   G. Gypsum

   H. Scale that registers in ounces and pounds

   I. Shovel

   J. Flat surfaces

   K. Five gallon container

   (NOTE: 176 gal.=1 cu. yd.)

   L. One or two gallon bucket or pan

II. Procedure

   A. Weigh out and place in the bucket the fertilizer materials

   B. Mix fertilizer materials until uniformly combined

   C. Place sand in a low pile on mixing floor

   D. Spread peat moss evenly over sand

   E. Spread fertilizer mix uniformly over peat moss and sand

   F. With shovel turn until all ingredients are uniformly mixed

PLANTING MEDIA
UNIT II

Job Sheet #2—PASTEURIZE SOIL

I. Tools and Equipment

  A. Soil

  B. Water

  C. Steam supply

  D. Porous canvas hoses

  E. Vinyl covering

  F. Soil thermometers

II. Procedure

  A. Measure soil

  B. Moisten all of the soil

  C. Lay a porous canvas hose under the soil

  D. Connect porous canvas hose to steam supply

  E. Tie cover down on edges

  F. Place soil thermometer at various locations

  G. Heat to 180° degrees for 30 minutes

PLANTING MEDIA
UNIT II

TEST

1. Match the terms on the right to the correct definitions.

____ a. Fertilizer material that provides the nutrients potassium and nitrogen

____ b. Expanded mineral that has a high water-holding capacity

____ c. Dehydrated remains of bog plants; high in water-holding capacity

____ d. Soil amendment that consists of powdered limestone that neutralizes acid in soil media

____ e. Soil amendment that neutralizes the acid in the soil media and provides the nutrient sulphur

____ f. Small rock grains used as an ingredient in media

____ g. Fertilizer material that provides the nutrient phosphorus

____ h. Partially decomposed remains of aquatic vegetation which has been preserved under water. Has very high water-holding capacity and is a basic ingredient in media mixes

____ i. Fertilizer material that provides the nutrients potassium and sulphur

____ j. Volcanic pumic used in media mixes in place of sand

____ k. Soil amendment that neutralizes the acid in the media and provides the nutrient magnesium

1. Peat moss
2. Vermiculite
3. Perlite
4. Sand
5. Sphagnum moss
6. Potassium nitrate
7. Potassium sulphate
8. Single sulpha phosphate
9. Dolomite limestone
10. Gypsum
11. Calcium carbonate lime

2. List five key characteristics that describe an ideal planting medium.

   a.

   b.

   c.

   d.

   e.

3. List three methods of sterilizing media mixtures.

   a.

   b.

   c.

4. List three ingredients used in a basic planting medium.

   a.

   b.

   c.

5. List six chemical ingredients used in a basic planting medium.

   a.

   b.

   c.

   d.

   e.

   f.

6. Arrange in order the five steps in mixing planting media. Place a 1 by the first step, a two by the second, etc.

   ____ a. Start a second pile with materials from the first

   ____ b. Dampen peat moss 1 to 3 days before mixing

   ____ c. Mixing with machine

   ____ d. Spread a second pile with materials from the first

   ____ e. Repeat until blended

7. Demonstrate the ability to:

   a. Mix the ingredients for one cubic yard of planting medium.

   b. Pasteurize soil.

PLANTING MEDIA
UNIT II

ANSWERS TO TEST

1. a. 6
   b. 2
   c. 5
   d. 11
   e. 10
   f. 4
   g. 8
   h. 1
   i. 7
   j. 3
   k. 9
2. a. Porous
   b. Dense
   c. Sterile
   d. Nutritious
   e. Lightweight
3. a. Steam
   b. Chemical
   c. Dry heat
4. Any three of the following:
   a. Sand
   b. Peat
   c. Perlite
   d. Vermiculite
   e. Sphagnum moss

5. a. Potassium nitrate
   b. Potassium sulphate
   c. Single sulpha phosphate
   d. Dolomite limestone
   e. Gypsum
   f. Calcium carbonate lime

6. a. 3
   b. 1
   c. 5
   d. 2
   e. 4

7. Performance skills evaluated to satisfaction of instructor.

AGRICULTURAL CHEMICALS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to name pests on which chemicals are used and list ways chemicals enter the body and safety rules to observe when using and storing chemicals. The student should be able to properly dispose of empty chemical containers and select proper protective clothing and accessories when using chemicals. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with agricultural chemicals to the correct definitions.
2. Name five major types of pests on which chemicals are used.
3. Select from a list that all chemical labels must contain.
4. List three general safety rules to follow before attempting to use chemicals.
5. Explain in writing the responsibility of a land grant college in regard to agricultural chemicals.
6. Select from a list three benefits from using chemicals.
7. Describe three types of insecticides and how each works.
8. List three methods by which chemicals enter the body.
9. List three safety precautions to follow when storing chemicals.
10. List two means of disposing of empty chemical containers.
11. Select from a list proper clothing and accessories necessary for the protection of anyone handling chemicals.

AGRICULTURAL CHEMICALS
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information sheets.
- C. Make transparencies.
- D. Collect chemical container labels for use in the classroom.
- E. Discuss unit and specific objectives.
- F. Discuss information sheet.
- G. Discuss chemical labels on containers.
- H. Give test.

II. Student:

- A. Read objectives.
- B. Study information sheet.
- C. Take additional notes.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this test:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
    1. TM 1—Bacteria
    2. TM 2—Viruses
    3. TM 3—Fungi
    4. TM 4—Nematodes
    5. TM 5—Key Words on Labels
    6. TM 6—Key words on Labels (Continued)
    7. TM 7—Proper Clothing and Accessories

D. Test

E. Answers to test

II. References:

A. U.S., Department of Agriculture and Environmental Protection Agency. *"Apply Pesticides Correctly: A Guide for Commercial Applicators."* Washington, D.C.: Government Printing Office, 1975.

B. U.S., Department of Agriculture and Environmental Protection Agency. *"Apply Pesticides Correctly: A Guide for Private Applicators."* Washington, D.C.: Government Printing Office, 1975.

C. *"Herbicide Use in Nebraska."* Nebraska Extension Bulletin EC 76-130. Cooperative Extenion Service, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, Lincoln, Nebraska.

D. *"Herbicides and Soils."* Nebraska Extension Bulletin G 74-160. Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, Lincoln, Nebraska.

E. *"Herbicide–Fertilizer Combination."* Nebraska Extension Bulletin G 74-164, Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln, Lincoln, Nebraska.

F. NebGuide. Lincoln, Nebraska: Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln.

AGRICULTURAL CHEMICALS
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Nematode—Small roundworm which lives in the soil and frequently enters the plants through the roots

B. Pesticide—Substance or mixture used for destroying or repelling such pests as insects, rodents, nematodes, weeds, and brush

C. Herbicide—Chemical substance used to kill herbaceous plants

D. Insecticide—Chemical substance used to kill or repell insects such as flies and grasshoppers

E. Rodenticide—Chemical substance or mixture of substances used to control rats, mice, and other rodents

F. Defoliant—Any substance or mixture of substances used to cause leaves or foliage to drop from plants, generally to facilitate harvesting

G. Fungicide—Chemical substance used to control fungi

H. Antibiotic—Any chemical or chemicals produced by living organisms that help alleviate or control bacterial diseases

I. Plant regulator—Any substance or mixture or substances that affects growth rate or other behavior of plants through physiological action

J. Poison—Substance which, if introduced into an organism in relatively small amounts, may chemically produce an injurious or deadly effect

K. Toxicity—Degree of poisonousness of a substance

L. Absorption—Process occurring when the material gains entry into the bloodstream

M. Acute exposure—Inhalation or absorption of large amounts of chemicals in a short period of time

N. Chronic exposure—Inhalation or absorption of relatively small amounts of poison over a long duration (days, months, years)

O. Hazard—Danger or probability that injury will result from the use of a substance in a given quantity and manner

P. Safety—Practical certainty that injury will not result from the use of a given substance

INFORMATION SHEET

II. Major types of pests

- A. Weeds
- B. Insects
- C. Diseases
  - 1. Bacteria (Transparency 1)
  - 2. Viruses (Transparency 2)
  - 3. Fungi (Transparency 3)
- D. Rodents
- E. Nematodes (Transparency 4)

III. Items that all chemical labels must contain

- A. POISON skull and crossbones on hazardous substances (Transparency 5)
- B. DANGER on highly toxic products (Transparency 5)
- C. Caution or warning on products that can cause illness or injury (Transparency 6)
- D. Name and address of manufacturer
- E. Statement of net contents
- F. Ingredients
- G. Directions for use
- H. Precautionary statements for using
- I. Date of expiration
- J. Antidote

IV. Safety rules to follow before attempting to use chemicals

- A. Read labels before using
- B. Use only when necessary
- C. Use according to recommendation
- D. Avoid spray and dust drift

INFORMATION SHEET

E. Keep away from livestock

F. Cover feed and water containers when using

V. Land grant college's responsibility in regard to agricultural chemicals

A. Research

B. Development

C. Dissemination of information

VI. Benefits from using chemicals

A. Increases production

B. Reduces loss caused from pests

C. Controls undesirable vegetation

1. Grass

2. Weeds

3. Brush

D. Acts as defoliant

VII. Types of insecticides and how each works

A. Stomach poison—Must enter the digestive tract of the insect before becoming effective

B. Contact poison—Can enter the insect by means other than the digestive tract

C. Repellent—Does not kill most insects although may injure certain types

VIII. Methods by which chemicals enter the body

A. Absorption through the skin

B. Swallowing

C. Absorption by breathing

D. Absorption through the eyes

INFORMATION SHEET

IX. Safety precautions for storing chemicals

  A. Store in original containers

  B. Store away from children

  C. Store away from feed

  D. Store in a cool, dry area

  E. Store in a locked cabinet

X. Means of disposing of empty containers

  A. Burning

  (CAUTION: Hazardous fumes may be given off when burned.)

  B. Burying

XI. Proper protective clothing and accessories (Transparency 7)

  A. Rubber gloves

  B. Rubber boots

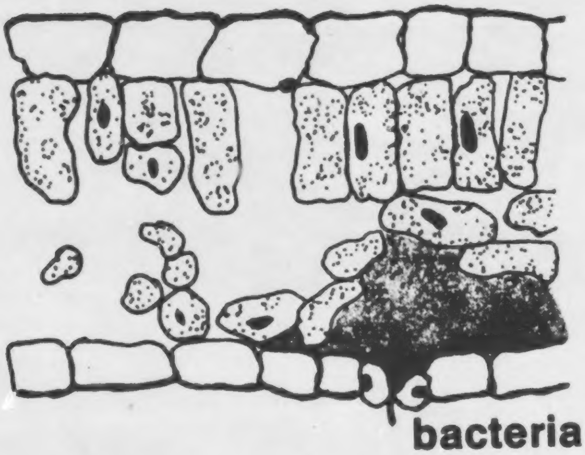
  C. Safety goggles

  D. Breathing apparatus (respirator)

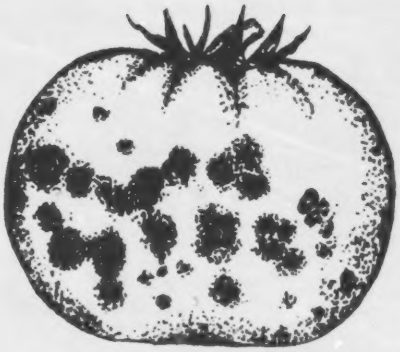
  E. Head protection

  F. Rubber apron or slicker suit

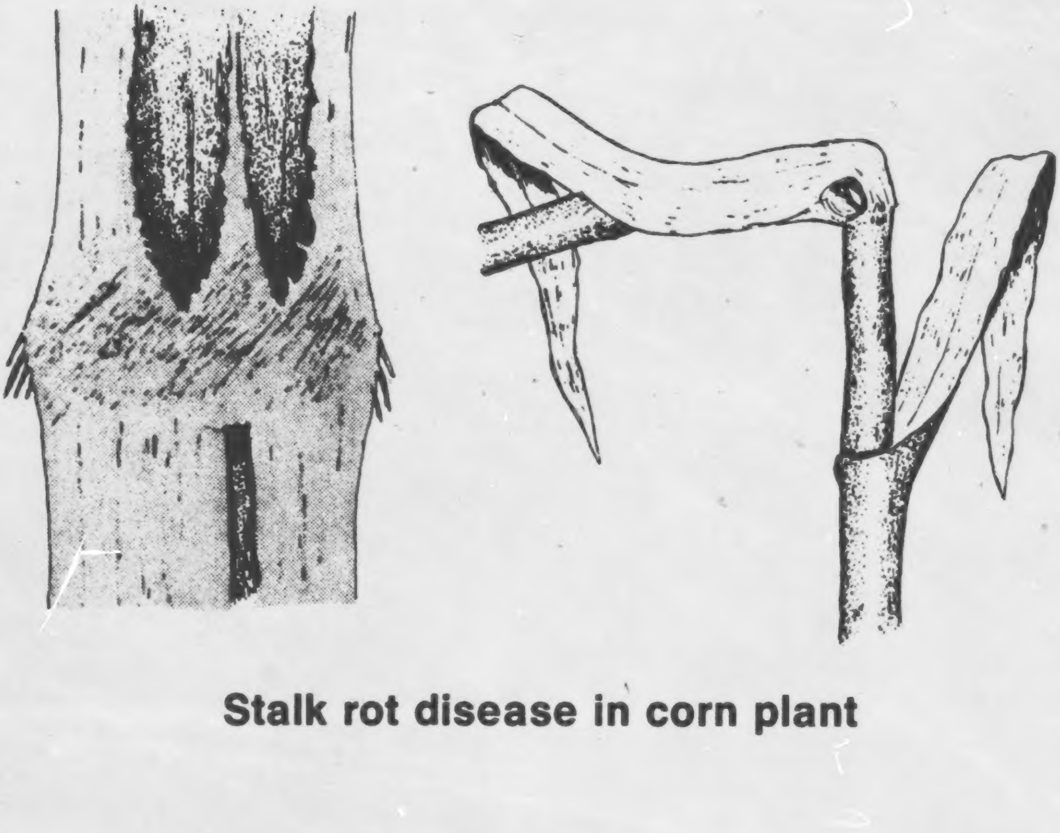
Bacterial Diseases



Bacteria entering through a Stomata of leaf section

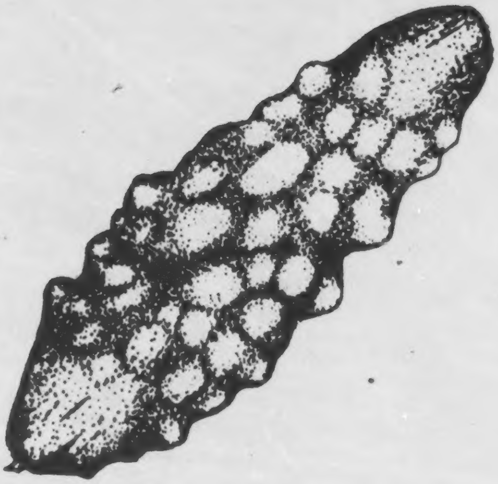


Bacterial spot on tomato

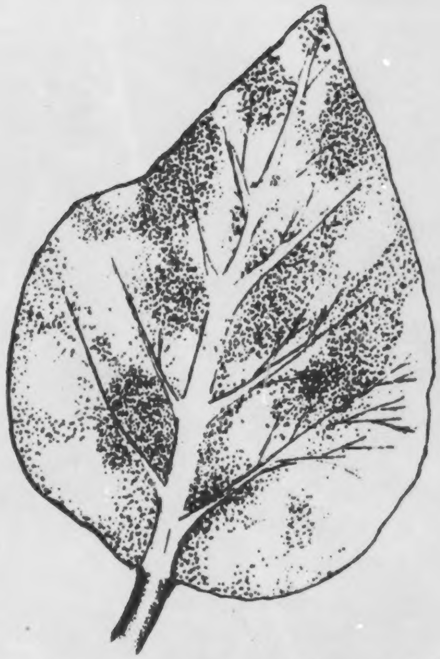


Stalk rot disease in corn plant

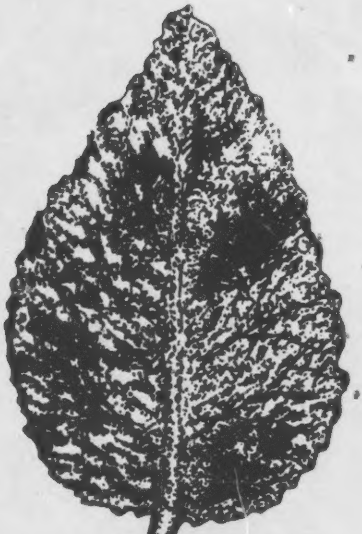
Viruses



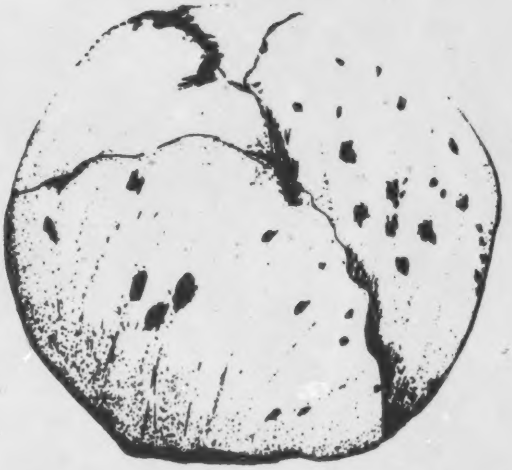
Cucumber with dark green warts-
Mosaic virus



Dark green mottling due to
Mosaic virsus

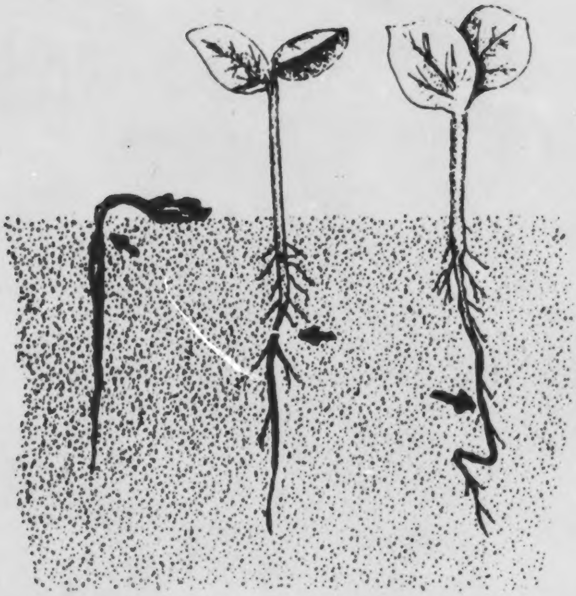


Leaf wrinkled due to virus

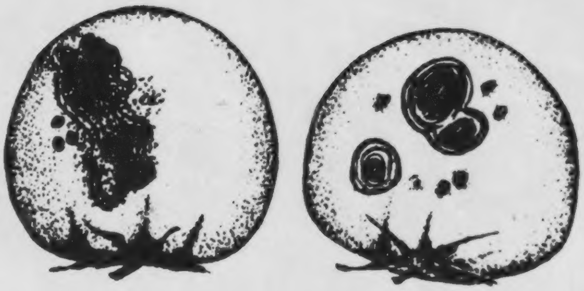


Mosaic virus on cabbage

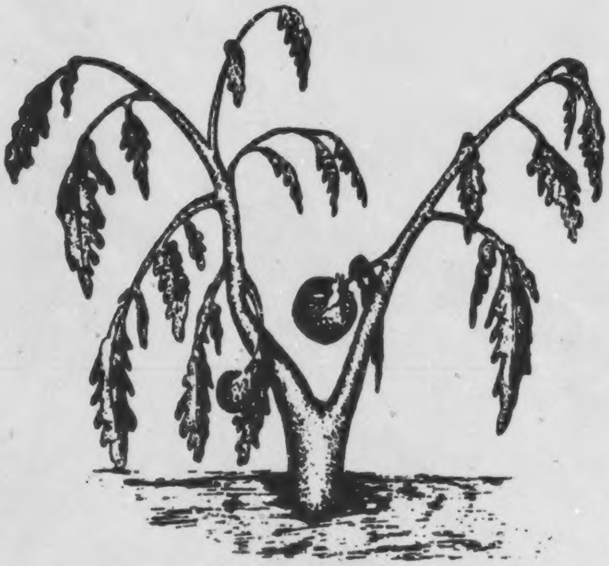
Fungi



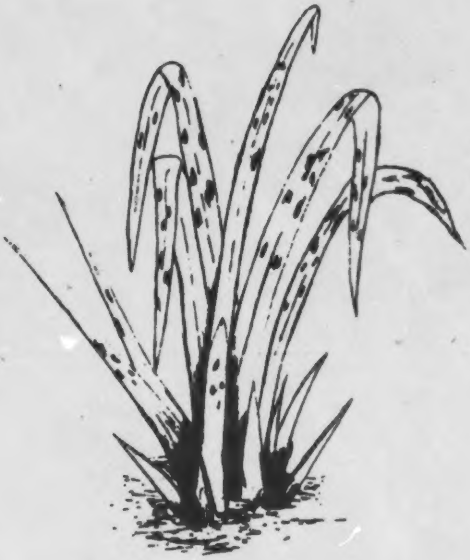
Young plant roots destroyed by fungi



Soil rot in wet soil

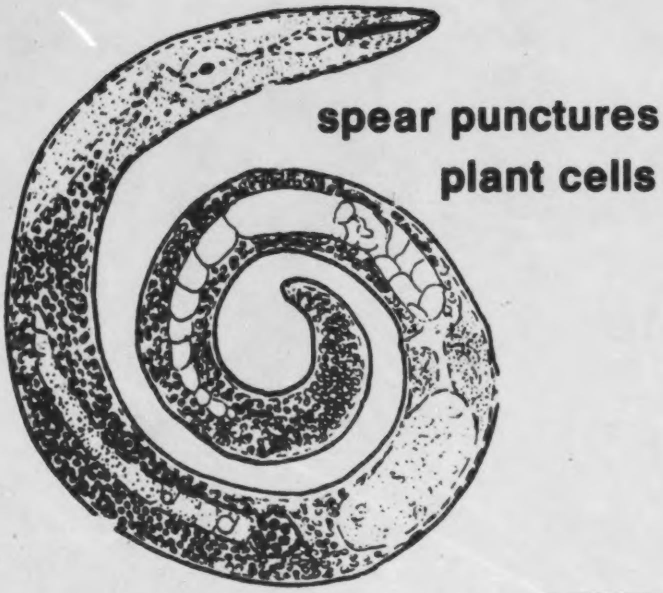


Wilt-caused by fungi entering root and stem



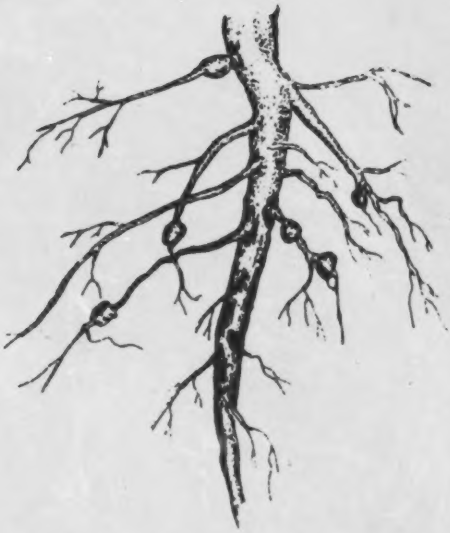
Rust fungus on grass

Nematodes

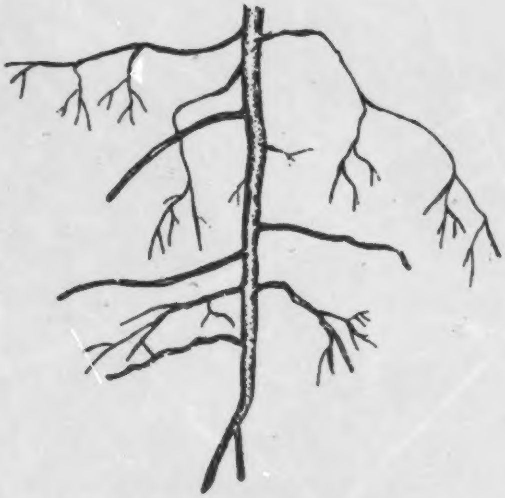


spear punctures plant cells

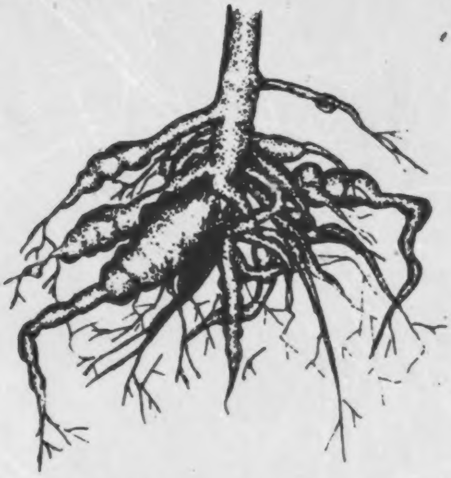
Nematode- size less than 2.0 mm



Galls or knots on roots

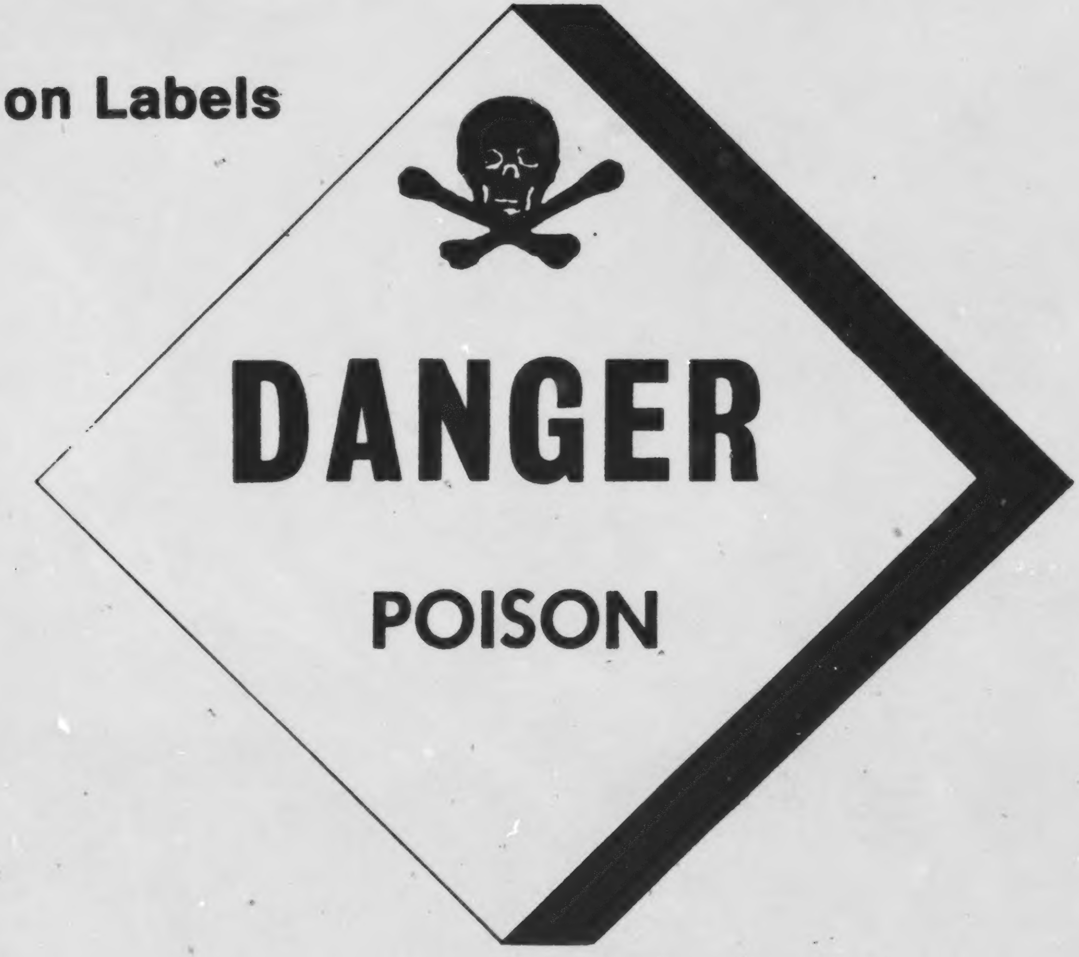


Stubby root or reniform Nematode



Root knot disease

Key Words on Labels

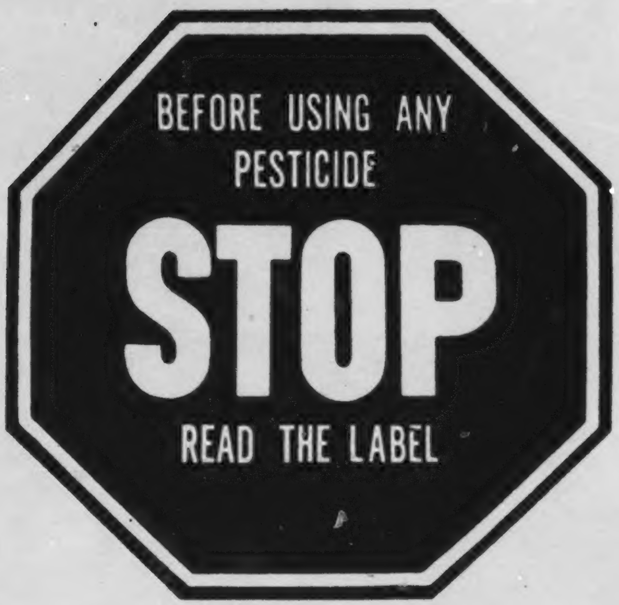

DANGER
POISON

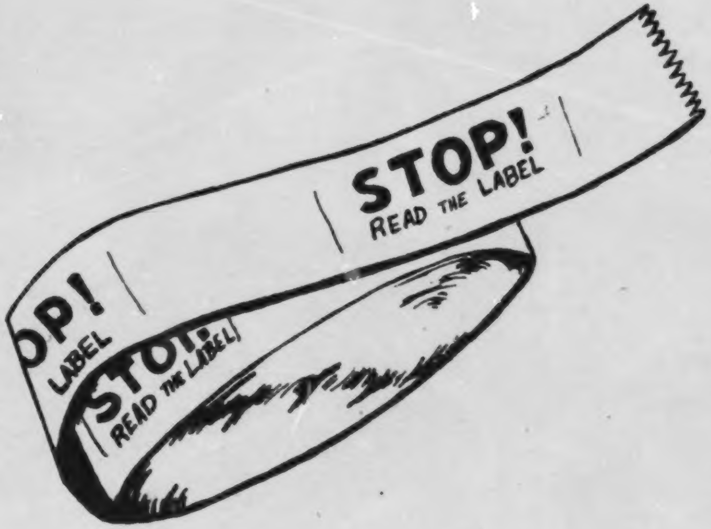
TM 5

H-67-A

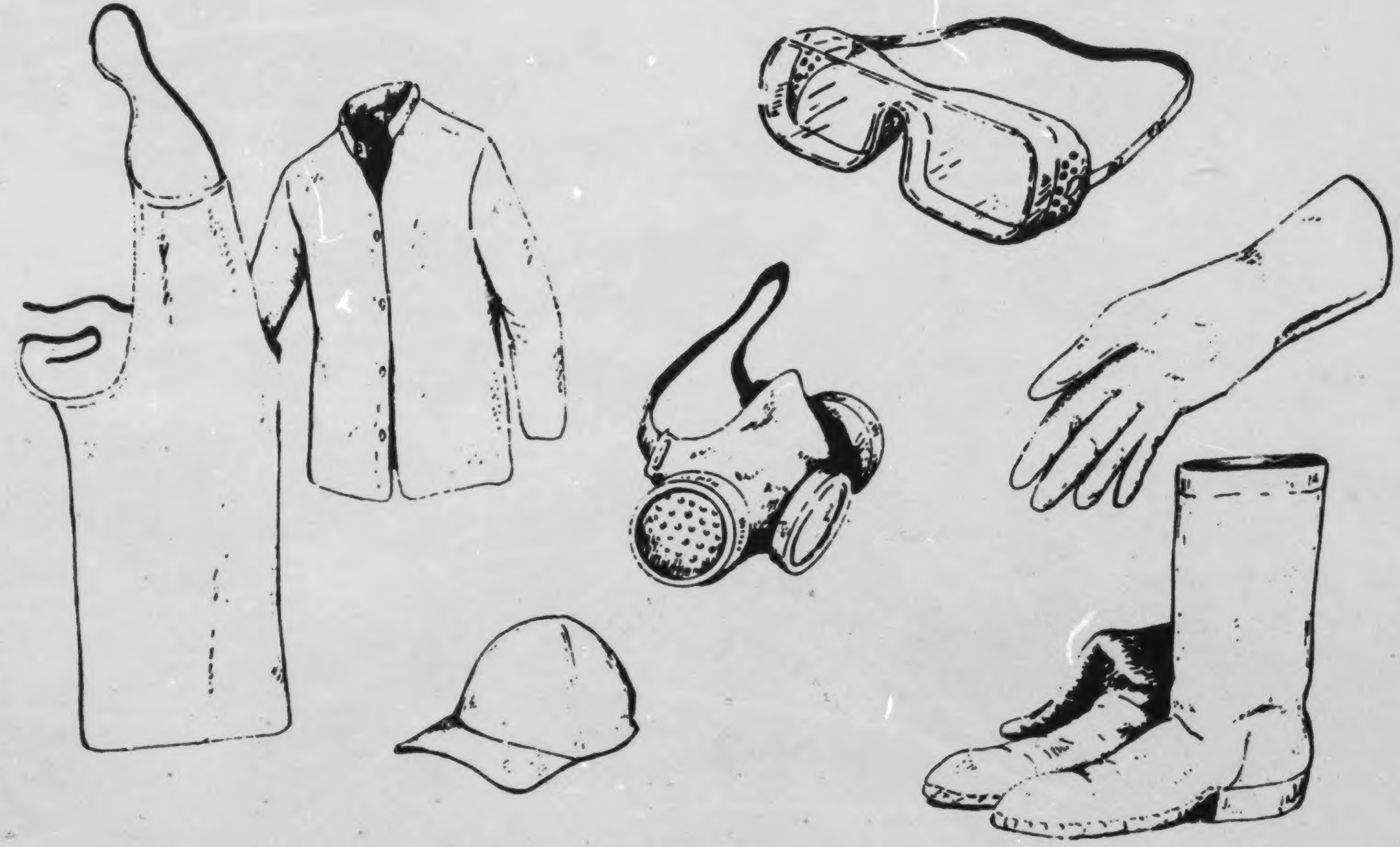
Key Words on Labels

(Continued)


BEFORE USING ANY PESTICIDE
STOP
READ THE LABEL


STOP!
READ THE LABEL
STOP!
READ THE LABEL
OP!
LABEL

Proper Clothing And Accessories



TM 7

H-71-A

AGRICULTURAL CHEMICALS
UNIT III

TEST

1. Match the terms on the right to the correct definitions.

____ a. Any substance or mixture of substances used to cause leaves or foliage to drop from plants, generally to facilitate harvesting

____ b. Small roundworm which lives in the soil and frequently enters the plants through the roots

____ c. Chemical substance used to control fungi

____ d. Any chemical or chemicals produced by living organisms that help alleviate or control bacterial diseases

____ e. Chemical substance used to kill or repell insects such as flies and grasshoppers

____ f. Substance which, if introduced into an organism in relatively small amounts, may chemically produce an injurious or deadly effect

____ g. Process occurring when the materials gain entry into the bloodstream

____ h. Practical certainty that injury will not result from the use of a given substance

____ i. Inhalation or absorption of large amounts of chemicals in a short period of time

____ j. Degree of poisonousness of a substance

____ k. Danger or probability that injury will result from the use of a substance in a given quantity and manner

____ l. Any substance or mixture of substances that affects growth rate or other behavior of plants through physiological action

1. Pesticide
2. Rodenticide
3. Antibiotic
4. Acute exposure
5. Safety
6. Nematode
7. Defoliant
8. Plant regulator
9. Chronic exposure
10. Herbicide
11. Fungicide
12. Toxicity
13. Absorption
14. Insecticide
15. Poison
16. Hazard

___ m. Inhalation or absorption of relatively small amounts of poison over a long duration (days, months, or years)

___ n. Substance or mixture used for destroying or repelling such pests as insects, rodents, nematodes, weeds, and brush

___ o. Chemical substance used to kill herbaceous plants

___ p. Chemical substance or mixture of substances used to control rats, mice, and other rodents

2. Name five major types of pests on which chemicals are used.

a.

b.

c.

d.

e.

3. Select from the list below the items that all chemical labels must contain by placing and "X" in the blanks.

___ a. Antidote

___ b. Ingredients

___ c. Inventor's name

___ d. Date of expiration

___ e. Date chemicals were identified

___ f. Directions for use

___ g. Date container was made

___ h. Name and address of manufacturer

___ i. Date manufactured

___ j. Statement of net contents

___ k. Cost per pound of chemical

4. List three general safety rules to follow before attempting to use chemicals.

   a.

   b.

   c.

5. Explain in writing the responsibility of a land grant college in regard to agricultural chemicals.

6. Select from the list three benefits from using chemicals by placing an "X" in the blanks.

   ____ a. Eradicates disease

   ____ b. Increases production

   ____ c. Eradicates screwworm

   ____ d. Controls undesirable vegetation

   ____ e. Acts as defoliant

7. Describe three types of insecticides and how each works.

   a.

   b.

   c.

8. List three methods by which chemicals enter the body.

   a.

   b.

   c.

9. List three safety precautions to follow when storing chemicals.

   a.

   b.

   c.

10. List two means of disposing of empty chemical containers.

    a.

    b.

11. Select from the list below proper clothing and accessories necessary for the protection of anyone handling chemicals by placing an "X" in the blanks.

    ____ a. Rubber gloves

    ____ b. Clean water

    ____ c. Safety goggles

    ____ d. Rubber apron or slicker suit

    ____ e. Head protection

    ____ f. Breathing apparatus (respirator)

AGRICULTURAL CHEMICALS
UNIT III

ANSWERS TO TEST

1. a. 7
   b. 6
   c. 11
   d. 3
   e. 14
   f. 15
   g. 13
   h. 5.
   i. 4
   j. 12
   k. 16
   l. 8
   m. 9
   n. 1
   o. 10
   p. 2

2. a. Weeds
   b. Insects
   c. Diseases
   d. Rodents
   e. Nematodes

3. a, b, d, f, h, j

4. Any three of the following:
   a) Read labels before using
   b) Use only when necessary
   c) Use according to recommendation
   d) Avoid spray or dust drift
   e) Keep away from livestock
   f) Cover feed and water containers when using

5. Explanation should include:
   a) Research
   b) Development
   c) Dissemination of information

6. b, d, e

7. Description should include:

   a) Stomach poison—Must enter the digestive tract of the insect before becoming effective

   b) Contact poison—Can enter the insect by means other than the digestive tract

   c) Repellent—Does not kill most insects although may injure certain types

8. Any three of the following:

   a) Absorption through the skin

   b) Swallowing

   c) Absorption by breathing

   d) Absorption through the eyes

9. Any three of the following:

   a) Store in original containers

   b) Store away from children

   c) Store away from feed

   d) Store in a cool, dry area

   e) Store in a locked cabinet

10. a. Burning

    b. Burying

11. a, c, d, e, f

ORGANIC MATTER
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to list basic facts about organic matter and select factors affecting the rate of decomposition. The student should also be able to list ways organic matter affects the soil, is lost from the soil, and can be applied to the soil. The student should also be able to list the different properties of humus. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with organic matter with the correct definitions.
2. List three facts about organic matter.
3. List five reasons organic matter is important to crop production.
4. Select from a list of factors affecting the rate of decomposition.
5. List three ways organic matter affects the soil.
6. Select from a list factors affecting the amount of organic matter in soil.
7. State the desirable percentage of organic matter for productive soils.
8. List four factors causing the loss of organic matter from soil.
9. List five types of organic matter that can be applied to soil.
10. List five properties of humus.

ORGANIC MATTER
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information sheets.

   E. Give test.

II. Students:

   A. Read objectives.

   B. Study information sheets.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheets

   C. Test

   D. Answers to test

II. References:

   A. Hartman, H. T., and Kester, D. E. *Plant Propagation: Principles and Practices.* Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1964.

   B. *Garden Seed Production Information Manual.* Downers Grove, Illinois: Vaughn's Seed Company. 1978.

ORGANIC MATTER
UNIT IV

INFORMATION SHEET

I. Terms and definitions

  A. Decomposition—Process of separation into constituents, parts, or elements by chemical action or natural decay

  B. Lignin—Organic substance which, with cellulose, forms the chief part of woody tissue, making up 40% to 45% of total humus

  C. Compost—Mixture of soil and partly decayed organic matter or humus that is used to improve garden and potting soil

  D. Humus—Dark brown substance; end product of decomposition containing organic matter that gives color and other properties to soil

  E. pH—Number used by chemists to indicate the relative amount of acid or alkali in a solution

  F. Crop residue—Portion of a plant or crop left after harvest

II. Facts about organic matter

  A. Easily depleted

  B. Can be found in all stages of decomposition

  C. Consists of living materials in soil that come from either plants or animals

III. Importance of organic matter in crop production

  A. Increases moisture-holding ability in sandy or "light" soils

  B. Improves aeration in clay or "heavy" soils

  C. Holds nutrients

  D. Improves soil structure

  E. Reduces water run-off and erosion in clay or "heavy" soils

IV. Factors affecting the rate of decomposition

  A. Amount, age, and chemical composition of organic matter

  B. Soil condition

  C. Climate

INFORMATION SHEET

V. Ways organic matter affects soil

  A. Chemically

  B. Physically

  C. Biologically

VI. Factors affecting the amount of organic matter in soil

  A. Climate

  B. Vegetative cover

  C. Drainage

  D. Topography

  E. Fertilizer

VII. Desirable percentage for organic matter for productive soils—approximately 4%

VIII. Factors causing the loss of organic matter from soil

  A. Decay

  B. Cropping

  C. Erosion

  D. Fire

IX. Types of organic matter that can be applied to soils

  A. Crop residues

  B. "Green manure"

  C. Manures

  D. Grass clippings and leaves

  E. Sawdust

  F. Peat moss

  G. Compost

INFORMATION SHEET

X. Properties of humus

  A. Most active part of the soil

  B. Holds large quantities of nutrients

  C. Holds large quantities of water

  D. Prevents sudden chemical changes in the soil

  E. Stabilizes soil structure

ORGANIC MATTER
UNIT IV

TEST

1. Match the terms on the right to the correct definitions.

    ___ a. Process of separation into constituents, parts, or elements by chemical action or natural decay

    ___ b. Mixture of soil and partly decayed organic matter or humus that is used to improve garden and potting soil

    ___ c. Dark brown substance, end product of decomposition containing organic matter that gives color and other properties to soil

    ___ d. Organic substance which, with cellulose, forms the chief part of woody tissue, making up 40% to 45% of total humus

    ___ e. Portion of a plant or crop left after harvest

    1. Lignin
    2. Compost
    3. Decomposition
    4. Humus
    5. Crop residue

2. List three facts about organic matter.

    a.

    b.

    c.

3. List five reasons organic matter is important to crop production.

    a.

    b.

    c.

    d.

    e.

4. Select from the list below factors affecting the rate of decomposition by placing an "x" in the correct blanks.

   ___ a. Chemical composition of organic matter

   ___ b. Temperature

   ___ c. Soil condition

   ___ d. Climate

   ___ e. Humus

5. List three ways organic matter affects the soil.

   a.

   b.

   c.

6. Select from a list factors affecting the amount of organic matter in soil by placing an "x" by the true statement.

   ___ a. Climate

   ___ b. Soil condition

   ___ c. Topography

   ___ d. Oxygen content

   ___ e. Fertilizer

7. State the desirable percentage of organic matter for productive soils.

8. List four factors causing the loss of organic matter from soil.
    a.
    b.
    c.
    d.

9. List five types of organic matter that can be applied to soil.
    a.
    b.
    c.
    d.
    e.

10. List five properties of humus.
    a.
    b.
    c.
    d.
    e.

ORGANIC MATTER
UNIT IV

ANSWERS TO TEST

1. a. 3
   b. 2
   c. 4
   d. 1
   e. 5

2. a. Easily depleted

   b. Can be found in all stages of decomposition

   c. Consists of living materials in soil that come from either plants or animals

3. a. Increases moisture holding ability in sandy or "light" soils

   b. Improves aeration in clay or "heavy" soils

   c. Holds nutrients

   d. Improves soil structure

   e. Reduces water run-off and erosion in clay or "heavy" soils

4. a,b,d

5. a. Chemically

   b. Physically

   c. Biologically

6. a,c,e

7. 4%

8. a. Decay

   b. Cropping

   c. Erosion

   d. Fire

9. Any five of the following:
    a) Crop residues
    b) "Green manure"
    c) Manures
    d) Grass clippings and leaves
    e) Sawdust
    f) Peat moss
    g) Compost

10. a) Most active part of the soil
    b) Holds large quantities of nutrients
    c) Holds large quantities of water
    d) Prevents sudden chemical changes in the soil
    e) Stabilizes soil structures

ORGANIC FERTILIZERS
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to list sources of organic matter, factors regarding nature of humus, and organic matter production methods. The student should also be able to describe two other sources of organic fertilizers. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with organic fertilizer with the correct definition.
2. List three sources of soil organic matter.
3. Select from a list factors affecting the rate of decomposition of organic matter.
4. List four factors regarding the nature of humus.
5. List two organic matter production methods.
6. List six functions of crop growing to produce organic matter.
7. Describe two organic matter production methods.
8. Describe two other sources or organic fertilizers.
9. Demonstrate the ability to construct a compost pile.

ORGANIC FERTILIZERS
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheet.

  C. Discuss unit and specific objectives.

  D. Discuss information sheets.

  E. Demonstrates and discuss procedures outlined in job sheet.

  F. Give test.

II. Students:

  A. Read objectives.

  B. Study information sheets.

  C. Demonstrate the ability to accomplish the procedures outlined in job sheet.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheets

  C. Job sheet #1—Construct a Compost Pile

  D. Test

  E. Answer to test

II. References:

  A. Hartman, H. T., and Kestor, D. E. *Plant Propagation: Principles and Practices* Englewood Cliffs, New Jersey: Prentice Hall, 1964.

  B. *Garden Seed Product Information Manual:* Downers Grove, Illinois; Vaughn's Seed Company, 1978.

ORGANIC FERTILIZERS
UNIT V

INFORMATION SHEET

I. Terms and definitions

   A. Cation exchange—Chemical process whereby plants absorb minerals from soil

   B. Artificial manure (synthetic)—Consists of the decomposition of organic matter under more or less controlled conditions

   C. Lignin—Organic substance which, with cellulose, forms the chief part of woody tissue, 40% to 45% of total humus

   D. Lignocellulose—Substance making up the woody and fibrous parts of a plant, consisting of lignin combined with cellulose

II. Sources of soil organic matter

   A. Dead plants

   B. Animal remains

   C. Dead soil organisms

III. Factors affecting the rate of decomposition of organic matter

   A. Soil temperature

   B. Soil aeration and moisture

   C. Soil reaction

   D. Initial chemical composition of organic matter

IV. Nature of humus

   A. Cation exchange

   B. Phosphate availability

   C. Reducing aluminum toxicity in the soil

   D. Water-holding capacity and soil aeration

V. Organic matter production methods

   A. Growing of crops

   B. Production of manure

INFORMATION SHEET

VI. Functions of crop growing to produce organic matter

- A. Provide a cover for the soil
- B. Add organic matter
- C. Conserve supplies of certain essential elements
- D. Retard erosion
- E. Check vegetative growth of crop plants
- F. Retain snow in cold climates, keep roots and soil warm

VII. Organic matter production methods

- A. Animal matter
    1. Mass of organic compounds in various states of decomposition
    2. Compounds decompose slowly; others quickly
    3. Finally changes to humus

       (NOTE: There is a disadvantage to this method in that huge quantities of manure are needed to equal a very small amount of commercial fertilizer.)
- B. Artificial manure
    1. Various types of organic matter may be used

       Examples: Straw, hay, lawn clippings, leaves
    2. Organic matter is treated with commercial fertilizer and lime
    3. Water supply helps break down artificial manure

VIII. Other sources of organic fertilizers

- A. Peat
    1. Free from disease pests
    2. High water-holding capacity

INFORMATION SHEET

B. Compost

  1. Mixture of soil and any type of decayed organic matter
  2. Properly prepared compost is free of weeds and odor
  3. Rich in plant nutrients

C. Natural plant food sources

  1. Activated sludge
  2. Animal tankage
  3. Alfalfa hay
  4. Blood meal
  5. Bone meal
  6. Fresh horse or cattle manure
  7. Caster pomace
  8. Cocoa shells
  9. Dried coffee grounds
  10. Cottonseed meal
  11. Fish scrap
  12. Green sand
  13. Guano
  14. Fresh hen manure
  15. Hoof meal
  16. Sea weed
  17. Fresh sheep manure
  18. Wood ashes

ORGANIC FERTILIZERS
UNIT V

JOB SHEET #1—CONSTRUCT COMPOST PILE

I. Equipment

- A. Variety of organic material (leaves, grass clippings, saw dust)
- B. Spade
- C. Pitch fork
- D. Patch of ground
- E. Soil

II. Procedure

- A. Dig a pit, minimum size 3x3x3 feet
- B. Make layers of organic material and soil
- C. Water thoroughly
- D. Apply cover to obtain faster decomposition
- E. Turn the pile and water as needed; keep moist
- F. Add organic materials as accumulated
- G. Add earth worms if necessary to help decompose organic materials
- H. Use when desired texture is reached

  (NOTE: Texture should be a soft, decomposed texture.)

ORGANIC FERTILIZERS
UNIT V

TEST

1. Match the terms on the right to the correct definitions.

____ a. Chemical process whereby plants absorb minerals from soil

____ b. Consists of the decomposition of organic matter under more or less controlled conditions

____ c. Organic substance which, with cellulose, forms the chief part of woody tissue, 40% to 45% of total humus

____ d. Substance making up the woody and fibrous parts of a plant, consisting of lignin combined with cellulose

1. Lignin
2. Lignocellulose
3. Artificial manure (synthetic)
4. Cation exchange

2. List three sources of soil organic matter.

a.

b.

c.

3. Select from the list below factors affecting the rate of decomposition of organic matter.

____ a. Soil reaction

____ b. Soil topagraphy

____ c. Soil temperature

____ d. Soil aeration and moisture

4. List four factors regarding the nature of humus.

a.

b.

c.

d.

5. List two organic matter production methods.

   a.

   b.

6. List six functions of crop growing to produce organic matter.

   a.

   b.

   c.

   d.

   e.

   f.

7. Describe two kinds of organic production methods.

   a.

   b.

8. Describe the two sources of organic fertilizers given below.

   a. Peat

   b. Compost

9. Demonstrate the ability to construct a compost pile.

ORGANIC FERTILIZERS
UNIT V

ANSWERS TO TEST

1. a. 4
   b. 3
   c. 1
   d. 2
2. a. Dead plants
   b. Animal remains
   c. Dead soil organisms
3. a,c,d,
4. a. Cation exchange
   b. Phosphate availability
   c. Reducing aluminum toxicity in the soil
   d. Water-holding capacity and soil aeration
5. a. Growing of crops
   b. Production of manure
6. a. Provide a cover for the soil
   b. Add organic matter
   c. Conserve supplies of certain essential elements
   d. Retard erosion
   e. Check vegetative growth of crop plants
   f. Retain snow in cold climates; keep roots and soil warm

7. Description should include:
    a) Animal manure
        1) Mass of organic compounds in various states of decomposition
        2) Compounds decompose slowly, others quickly
        3) Finally changes to humus
    b) Artificial manure
        1) Various types of organic matter may be used
        2) Organic matter is treated with commercial fertilizer and lime
        3) Water supply helps break down artificial manure
8. Description should include:
    a) Peat
        1) Free from disease pests
        2) High water-holding capacity
    b) Compost
        1) Mixture of soil and any type of decayed organic matter
        2) Properly prepared compost is free of weeds and odor
        3) Rich in plant nutrients
9. Performance skill evaluated to satisfaction of instructor.

FERTILIZERS
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to list characteristics of major and minor plant nutrients. The student should be able to take a soil test, list plant growth information, and determine the amount of fertilizer to use. This knowledge will be evidenced through demonstration and by scoring eight-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with fertilizers to the correct definitions.
2. List three characteristics of major plant nutrients.
3. List the sixteen elements and their symbols known to be essential for plant growth.
4. List three characteristics of major plant nutrients.
5. List three characteristics of minor plant nutrients.
6. List three micro-elements necessary for plant growth usually found in sufficient quantity in most soils.
7. List four requirements that must be stamped on fertilizer bags according to state law.
8. Describe what 20-10-10 means according to fertilizer analysis.
9. Calculate application rates of fertilizer.
10. Demonstrate the ability to:

    a. Lime soil.

    b. Fertilize lawn with spreader.

FERTILIZERS
UNIT VI

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information, assignment, and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objectives.

  B. Study information sheets.

  C. Work assignment sheets and turn into instructor for grading.

  D. Demonstrate the ability to accomplish procedures outlined in job sheets.

  E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheets

  C. Transparency masters

    1. TM 1—Essential Elements

    2. TM 2—Required Fertilizer Bag Information

    3. TM 3—Fertilizer Analysis

D. Assignment sheet #1—Determine Required Rates of Fertilizer

E. Answers to assignment sheet

F. Job sheets

   1. Job Sheet #1—Lime Soil

   2. Job Sheet #2—Fertilize Lawn with Spreader

G. Test

H. Answers to test

II. Reference: McVicker, Malcolm H. *Using Commercial Fertilizers.* Danville, Illinois: The Interstate Printers and Publishers, Inc.

FERTILIZERS
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Formula—The quantity and grade of materials used in making a fertilizer mixture

B. Fertilizer—Any natural manufactured or processed material or mixture of materials that contains one or more of the recognized plant food elements, either liquid or dry

C. Ratio—The ratio of nitrogen, phosphate, and potash in a fertilizer

D. Grade—The total of the fertilizer analysis

E. Analysis—The percent content of total (N) nitrogen available (P) phosphorus expressed as P_2O_5 and the amount of water soluble (K) potassium expressed as K_2O

F. Brand—Trademark of the company which produced the fertilizer

G. Carrier—A fertilizer containing only one nutrient

H. Complete fertilizer—One which supplies all three of the major nutrients

I. Mixed fertilizer—A mixture of two carriers

J. Filler—The material added for weight to the fertilizer which does not contain N, P_2O_5, or K

K. Conditioner—The material added to the fertilizer in order to improve its physical condition

L. Acid soil—The soil having an acid reaction; the pH is below 7.0

M. Alkali soil—The soil that contains enough exchangeable sodium to adversely affect the growth of most crops

N. Alkaline soil—The soil having a basic reaction; the pH is above 7.0

O. Organic soil—A term used to refer to soils containing 20% or more organic matter

P. pH—A term used to indicate the degree of acidity or alkalinity of the soil

INFORMATION SHEET

- Q. Yield possibility—The yield obtained for a given cropping situation when all nutrients are adequate
- R. Water solubility—Refers to the percentage of the fertilizer which will be dissolved
- S. Percent sufficiency—The percent of the yield possibility obtained because of the deficiency of a plant nutrient
- T. Dry mixed—A granulated fertilizer made by combining selected plant food materials to obtain certain ratios and quanities of plant nutrients
- U. Liquid—Made by dissolving the correct proportion of the solid plant food carriers into water or by the neutralization process of neutralizing phosphoric acid ammonia
- V. Gas—Liquid fertilizer containing sold fertilizer materials which is dispersed under pressure and usually contains a higher analysis than clear liquid mixes.

II. Factors influencing use of fertilizers

- A. Crops
- B. Chemical condition of soil
- C. Physical condition of soil
- D. Insects and diseases
- E. Climatic conditions

III. Essential elements (Transparency 1)

- A. Carbon-C
- B. Hydrogen-H
- C. Oxygen-O
- D. Nitrogen-N
- E. Phosphorus-P
- F. Potassium-K
- G. Calcium-Ca
- H. Magnesium-Mg

INFORMATION SHEET

I. Sulfur-S

J. Iron-Fe

K. Zinc-Zn

L. Manganese-Mn

M. Copper-Cu

N. Boron-B

O. Molybdenum-Mo

P. Chloride-Cl

IV. Characteristics of major plant nutrients

A. Nitrogen

1. Part of every living cell
2. Part of the chlorophyl molecule
3. Gives dark green color
4. Aids and promotes seed development
5. Easily translocated

B. Phosphorus

1. Part of every living cell
2. Contributes to early maturing of crops
3. Necessary for seed formation
4. Stimulates root growth
5. Easily translocated

INFORMATION SHEET

C. Potassium

1. Necessary for production and translocation of carbohydrates
2. Aids in respiration
3. Controls water intake and respiration
4. Easily translocated
5. Promotes health and vigor of plants
6. Stiffens straw and stalks

V. Characteristics of minor plant nutrients

A. Calcium

1. Speeds decay of organic matter
2. Stimulates formation of nitrates
3. Promotes root and leaf growth
4. Necessary for nodulation of legumes

B. Magnesium

1. Necessary for chlorophyl or green coloring
2. Increases absorption of phosphorus
3. Aids in formation of fats and oils
4. Important in plant enzyme system

C. Sulfur

1. Necessary for nodule formation on legumes
2. Associated with plant enzyme systems
3. Easily translocated

VI. Micro-elements

A. Manganese

B. Boron

INFORMATION SHEET

C. Copper

D. Zinc

E. Iron

VII. Fertilizerbag requirements (Transparency 2)

A. Name, brand, or trademark

B. Analysis (guaranteed or chemical composition)

C. Net weight

D. Name and address of manufacturer

VIII. Fertilizer analysis (Transparency 3)

A. Consists of three figures

(NOTE: These three figures indicate the plant nutrient content of the material.)

B. First figure—Represents pounds of total nitrogen available in 100 pounds of fertilizer

C. Second figure—Represents pounds of total phosphorus available expressed as P_2O_5

D. Third figure—Represents pounds of water soluble potash expressed as K_2O

Example: 100 pounds of 20-10-10 fertilizer

1. 20 pounds of total nitrogen
2. 10 pounds of available phosphate
3. 10 pounds of water soluble potash

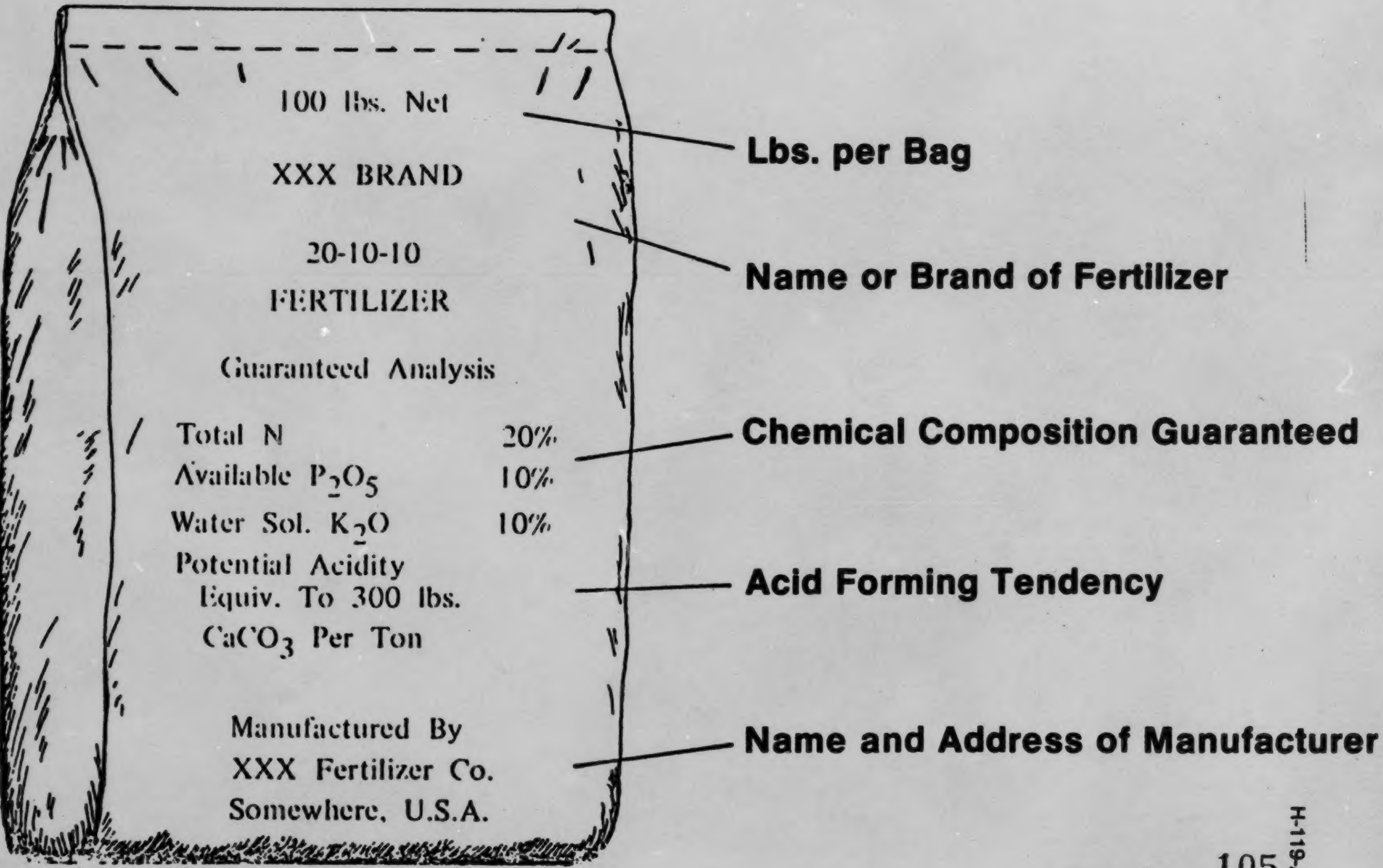
Essential Elements

NON-MINERAL	PRIMARY	SECONDARY
Carbon	Nitrogen	Calcium
Hydrogen	Phosphorus	Magnesium
Oxygen	Potassium	Sulfer

MICRO-ELEMENTS

Iron
Chloride
Manganese
Boron
Zinc
Copper
Molybdenum

Required Fertilizer Bag Information



100 lbs. Net

XXX BRAND

20-10-10
FERTILIZER

Guaranteed Analysis

Total N	20%
Available P_2O_5	10%
Water Sol. K_2O	10%

Potential Acidity
Equiv. To 300 lbs.
$CaCO_3$ Per Ton

Manufactured By
XXX Fertilizer Co.
Somewhere, U.S.A.

Lbs. per Bag

Name or Brand of Fertilizer

Chemical Composition Guaranteed

Acid Forming Tendency

Name and Address of Manufacturer

Fertilizer Analysis

20 – 10 – 10

⇧ **Total Nitrogen Available**

⇧ **Total Phosphorus Expressed as P_2O_5**

⇧ **Water Soluble Potash Expressed as K_20**

FERTILIZERS
UNIT VI

ASSIGNMENT SHEET #1: DETERMINE REQUIRED AMOUNT OF FERTILIZER.

I. Given the following information, determine the amount of fertilizer needed for one acre on an acre basis.

A. 400 pounds of nutrients wanted per acre

B. Percentage of nutrients in the fertilizer (20-15-5)

C. To cover 10 acres

D. Show computation

E. Give number of pounds needed per acre

F. Give number of 100 pound bags per acre

G. Give number of tons needed for 10 acres

H. Formula:

$$\text{acre basis} \div \frac{\text{Pounds of nutrient wanted}}{\text{Percentage of nutrient in fertilizer}} \text{ pounds needed per acre}$$

II. Given the following information, compute the amount of fertilizer needed per square foot on the square footage basis.

A. Nutrient rate — 25-10-5

B. Number of square feet — 3000

C. Number of square feet per acre — 43,560

D. Show computations.

E. How many pounds per square foot

F. Formula:

$$\text{Square Footage Basis} = \frac{\text{(Nutrient Rate) (Number of Square Feet)}}{\text{Number of Square feet per acre}} = \text{Pounds needed Per square foot}$$

FERTIZERS
UNIT VI

ANSWERS TO ASSIGNMENT SHEETS

ASSIGNMENT SHEET #1

I. A. 1 acre = 400 = 10,000 pounds needed per acre
40%

B. 10,000 pounds

C. 100 pound bags per acre

D. 50 Tons of Fertilizer for 10 acres

II. A. 1 square foot = (40) (3000) = 2.075
43560

B. 2.075 pounds per square foot

FERTILIZERS
UNIT VI

JOB SHEET #1—LIME SOIL

I. Equipment

  A. Lime spreader

  B. pH test kit

  C. Pulverized agricultural limestone

  D. Paper and pencil

II. Procedure

  A. Take pH test of soil sample

  B. Determine rate of lime required for 100 sq. ft.

  C. Determine total square footage to be limed

  D. Calculate quantity of lime needed

  E. Inspect lime spreader

  F. Distribute lime with spreader

  G. Distribute in straight even rows

  H. Clean and lightly oil moving parts

FERTILIZERS
UNIT VI

JOB SHEET #2—FERTILIZE LAWN WITH SPREADER

I. Equipment

  A. Lawn spreader

  B. Lawn fertilizer, 10-6-4 analyses

II. Procedure

  A. Inspect fertilizer spreader for operational fitness

  B. Clean fertilizer spreader

  C. Pace off lawn area to be fertilized

  D. Determine rate of fertilizer

  E. Set fertilizer spreader adjustment

  F. Direct fertilizer spreader in straight rows

  G. Shut off fertilizer spreader when filling

  H. Clean spreader when done

FERTILIZERS
UNIT VI

TEST

1. Match the terms on the right to the correct definitions.

____ a. A term used to indicate the degree of acidity or alkalinity of the soil

____ b. A mixture of two carriers

____ c. The quantity and grade of materials used in making a fertilizer mixture

____ d. A term used to refer to soils containing 20% or more organic matter

____ e. The material added for weight to the fertilizer which does not contain N, P_2O_5, or K

____ f. Any natural manufactured or processed material or mixture of materials that contain one or more of the recognized plant food elements, either liquid or dry

____ g. The soil having a basic reaction; the pH is above 7.0

____ h. The ratio of nitrogen, phosphate, and potash in a fertilizer

____ i. The soil that contains enough exchangeable sodium to adversely affect the growth of most crops

____ j. The total of the fertilizer analysis

____ k. The soil having an acid reaction; the pH is below 7.0

1. Acid soil
2. Alkali soil
3. Conditioner
4. Formula
5. pH
6. Fertilizer
7. Alkaline soil
8. Ratio
9. Organic soil
10. Grade
11. Yield possibility
12. Analysis
13. Complete fertilizer
14. Mixed fertilizer
15. Percent sufficiency
16. Filler
17. Brand
18. Carrier
19. Liquid fertilizer
20. Gas fertilizer
21. Dry mix fertilizer

____ l. The percent of content of total (N) nitrogen available (P) phosphorus expressed as P_2O_5 and the amount of water soluble (K) potassium expressed as K_2O

____ m. The material added to the fertilizer in order to improve its physical condition

____ n. The trademark of the company which produced the fertilizer

____ o. The material added to the fertilizer which does not contain N, P_2O_5, or K

____ p. The yield obtained for a given cropping situation when all nutrients are adequate

____ q. A fertilizer containing only one nutrient

____ r. The percent of the yield possibility obtained because of the deficiency of a plant nutrient

____ s. One which supplies all three of the major nutrients

____ t. Liquid fertilizer containing solid fertilizer materials which is dispersed under pressure and usually contains a high analysis then clear liquid mixer

____ u. Granulater fertilizer made by combining selected plant food materials to obtain certain ratio and quanities of plant nutrients

____ v. Made by dissolving correct proportion of the solid plant food carriers into water or by neutralization process of neutralizing phosphoric acid ammonia

2. List five factors that influence the use of fertilizers.

   a.

   b.

   c.

   d.

   e.

3. List the sixteen elements and their symbols known to be essential for plant growth.

a. ____________ Symbol ____________

b. ____________ Symbol ____________

c. ____________ Symbol ____________

d. ____________ Symbol ____________

e. ____________ Symbol ____________

f. ____________ Symbol ____________

g. ____________ Symbol ____________

h. ____________ Symbol ____________

i. ____________ Symbol ____________

j. ____________ Symbol ____________

k. ____________ Symbol ____________

l. ____________ Symbol ____________

m. ____________ Symbol ____________

n. ____________ Symbol ____________

o. ____________ Symbol ____________

p. ____________ Symbol ____________

4. List three characteristics for each of the major plant nutrients given below.

a. Nitrogen Characteristics: ______________________________

____

____

b. Phosphorus Characteristics: ______________________________

____

____

c. Potassium Characteristics: ____________________

____

____

5. List three characteristics for each of the minor plant nutrients given below.

a. Calcium Characteristics: ____________________

____

____

b. Magnesium Characteristics: ____________________

____

____

c. Sulfur Characteristics: ____________________

____

____

6. List three micro-elements necessary for plant growth which are usually found in sufficient quantity in most soils.

a.

b.

c.

7. List four requirements that must be stamped on fertilizer bags according to state law.

a.

b.

c.

d.

8. Describe what 20-10-10 means according to fertilizer analysis.

9. Calculate application rates of fertilizer.

10. Demonstrate the ability to:

    a. Lime soil.

    b. Fertilize lawn with spreader.

(NOTE: If activities 9 and 10 have not been accomplished prior to the test, ask your instructor when they should be completed.)

FERTILIZERS
UNIT VI

ANSWERS TO TEST

1. a. 5
   b. 14
   c. 4
   d. 9
   e. 16
   f. 6
   g. 7
   h. 8
   i. 2
   j. 10
   k. 1
   l. 12
   m. 3
   n. 17
   o. 16
   p. 11
   q. 18
   r. 15
   s. 13
   t. 20
   u. 21
   v. 19

2. a. Crops

   b. Chemical condition of soil

   c. Physical condition of soil

   d. Insects and diseases

3.

a.	Hydrogen	Symbol	*H*
b.	Oxygen	Symbol	*O*
c.	Carbon	Symbol	*C*
d.	Nitrogen	Symbol	*N*
e.	Phosphorus	Symbol	*P*
f.	Potassium	Symbol	*K*
g.	Calcium	Symbol	*Ca*
h.	Magnesium	Symbol	*Mg*
i.	Sulfur	Symbol	*S*
j.	Iron	Symbol	*Fe*
k.	Zinc	Symbol	*Zn*
l.	Manganese	Symbol	*Mn*
m.	Copper	Symbol	*Cu*
n.	Boron	Symbol	*B*
o.	Molybdenum	Symbol	*Mo*
p.	Chloride	Symbol	*Cl*

4. a) Nitrogen — Any three of the following characteristics:

   1) Part of every living cell
   2) Part of the chlorophyl molecule
   3) Gives dark green color
   4) Aids and promotes seed development
   5) Easily translocated

   b) Phosphorus — Any three of the following characteristics:

   1) Part of every living cell
   2) Contributes to early maturing of crops
   3) Necessary for seed formation
   4) Stimulates root growth
   5) Easily translocated

   c) Potassium — Any three of the following characteristics:

   1) Necessary for production and translocation of carbohydrates
   2) Aids in respiration
   3) Controls water intake and respiration
   4) Easily translocated
   5) Promotes health and vigor of plants
   6) Stiffens straw and stalks

5) a) Calcium — Any three of the following characteristics:

   1) Speeds decay of organic matter
   2) Stimulates formation of nitrates
   3) Promotes root and leaf growth
   4) Necessary for nodulation of legumes

   b) Magnesium — Any three of the following characteristics:

   1) Necessary for chlorophyl or green coloring
   2) Increases absorption of phosphorus
   3) Aids in formation of fats and oils
   4) Important in plant enzyme system

   c) Sulfur — The following characteristics:

   1) Necessary for nodule formation on legumes
   2) Associated with plant enzymes systems
   3) Easily translocated

6. Any three of the following:
    a. Maganese
    b. Boron
    c. Copper
    d. Zinc
    e. Iron
7. a. Name, brand, or trademark
    b. Analysis
    c. Net weight
    d. Name and address of manufacturer
8. Description should include:
    a) Consists of three figures
    b) First figure represents pounds of total nitrogen available in 100 pounds of fertilizer
    c) Second figure represents pounds of total phosphorus available expressed as P_2O_5
    d) Third figure represents pounds of water soluble potash expressed as K_2O
9. Evaluated to satisfaction of instructor.
10. Performance skills evaluated to satisfaction of instructor.

STARTING PLANTS FROM SEED
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to, list the basic kinds of containers used, list in order the steps for preparing containers for planting, distinguish between the characteristics of Jiffy-pots and Jiffy-7's, and list reasons seeds remain dormant. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with starting plants from seeds to the correct definitions.
2. List the three basic kinds of containers used in propagating plants from seed.
3. List in order the two steps in preparing containers for planting.
4. Distinguish between the characteristics of peat moss based containers.
5. List two reasons seeds remain dormant.
6. Select statements that are true regarding the planting of fine-sized and course-sized seeds.
7. State the general rule for covering seeds.
8. List four methods of watering newly sown crops.
9. Distinguish between information that should appear on seed flat labels for bedding plants and shrubs and trees.
10. Select from a list true statements concerning the care of germinating seeds.
11. Describe factors to consider when caring for newly emerged seedlings.
12. Demonstrate the ability to:
    a. Start plants from seeds in flats.
    b. Label plants.
    c. Sow seeds.

STARTING PLANTS FROM SEED
UNIT VII

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheets.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Give test.

II. Students:

   A. Read objectives.

   B. Study information sheets.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheets

   C. Transparency masters

      1. TM 1—Marking Rows in a Flat

      2. TM 2—Filling the Flat

      3. TM 3—Using the Screed and Tamp

      4. TM 4—Cross Section of Prepared Pot

5. TM 5—Tools to Moisten Soil

6. TM 6—Labeling Bedding Plants

7. TM 7—Covering the Flat

D. Job sheets

1. Job Sheet #1—Start Plants from Seeds in Flats

2. Job Sheet #2—Label Plants

3. Job Sheet #3—Sow Seeds

E. Test

F. Answers to test

II. References:

A. Hartman, H. T., and Kester, D. E. *Plant Propagation Principles and Practices:* Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1964.

B. *Garden Seed Product Information Manual:* Downers Grove, Illinois: Vaughn's Seed Company, *1978.*

STARTING PLANTS FROM SEED
UNIT VII

INFORMATION SHEET

I. Terms and definitions

  A. Flat—Shallow tray made of wood, plastic, or metal used for germinating seeds (Transparency 1)

  B. Screed—Straight-edged piece of wood used to remove excess soil from flat (Transparency 2)

  C. Tamp—Small piece of wood used to smooth and pack soil in a flat

  D. Row marker—Flat piece of wood with vertical pieces attached to one side; pressed down on soil to mark rows (Transparency 3)

  E. Syringe—Small rubber bulb with fine spray nozzle attached; used to water newly seeded crops

  F. Subirrigation—Watering system where water is allowed to filter upward through the soil

  G. Jiffy-pots—Pots made of 70% sphagnum peat moss and 30% wood fiber which allow roots to grow through

  H. Jiffy-7—Compressed peat pellet enclosed in a thin net; one-seventh of its expanded size

II. Basic kinds of containers used in propagating plants from seed

  A. Flats

  B. Clay or plastic pots

  C. Jiffy-pots and Jiffy 7

III. Preparing containers for planting

  A. Flats

    1. Fill flat with soil (Transparency 2)

    2. Screed and tamp (Transparency 3)

  B. Clay or plastic pots (Transparency 4)

    1. Place a piece of broken pot over drain hole, curved side up
    2. Fill pots within one inch of top

INFORMATION SHEET

IV. Characteristics of peat moss based containers

A. Jiffy-pots

1. Inexpensive
2. Porous walls permit good aeration
3. Pot walls hold water and provide an abundant, uniform supply
4. Lightweight
5. Completely sterile and disease-free

B. Jiffy-7's

1. Combine functions of pot and potting soil into one unit
2. Seeds started directly in them
3. Seedlings may be transplanted into them
4. Cuttings may be rooted in them

V. Seed dormancy

A. Hard seed coats

B. Dormant embryos

VI. Planting seeds

A. Planting fine-sized seeds

1. Separate seeds by a considerable distance
2. Gently tap the seed packet to release small amounts into the rows
3. Mix fine dry sand with seed to help keep seeds separated when sowing

B. Planting coarse-sized seeds

1. Place seeds close together but not touching
2. Tap seed packet gently to release small amounts into the rows

VII. Covering seeds—Cover seeds to depth 2-4 times their diameter

(NOTE: Most failures in growing seed occur from planting too deeply.)

INFORMATION SHEET

VIII. Methods of watering newly sown crops (Transparency 5)

   A. Fine spray syringe for fine seeds

   B. Hose and fine spray nozzle

   C. Subirrigation

   D. Newspaper oversoil and covered with water

IX. Information that should appear on seed flat labels (Transparency 6)

   A. Bedding plants

      1. Common name and variety of plant

      2. Type and color

      3. Planting date

      4. Sower's initials

   B. Shrubs and trees

      1. Genus

      2. Species

      3. Variety

      4. Planting date

      5. Sower's initials

X. Care of germinating seeds (Transparency 7)

   A. Place a pane of glass over the pot or flat

   B. Cover the glass with burlap or paper

   C. Lift the glass slightly on one side for ventilation

   D. Place seed material in a warm place at 65° F

   E. Do not place in direct sunlight

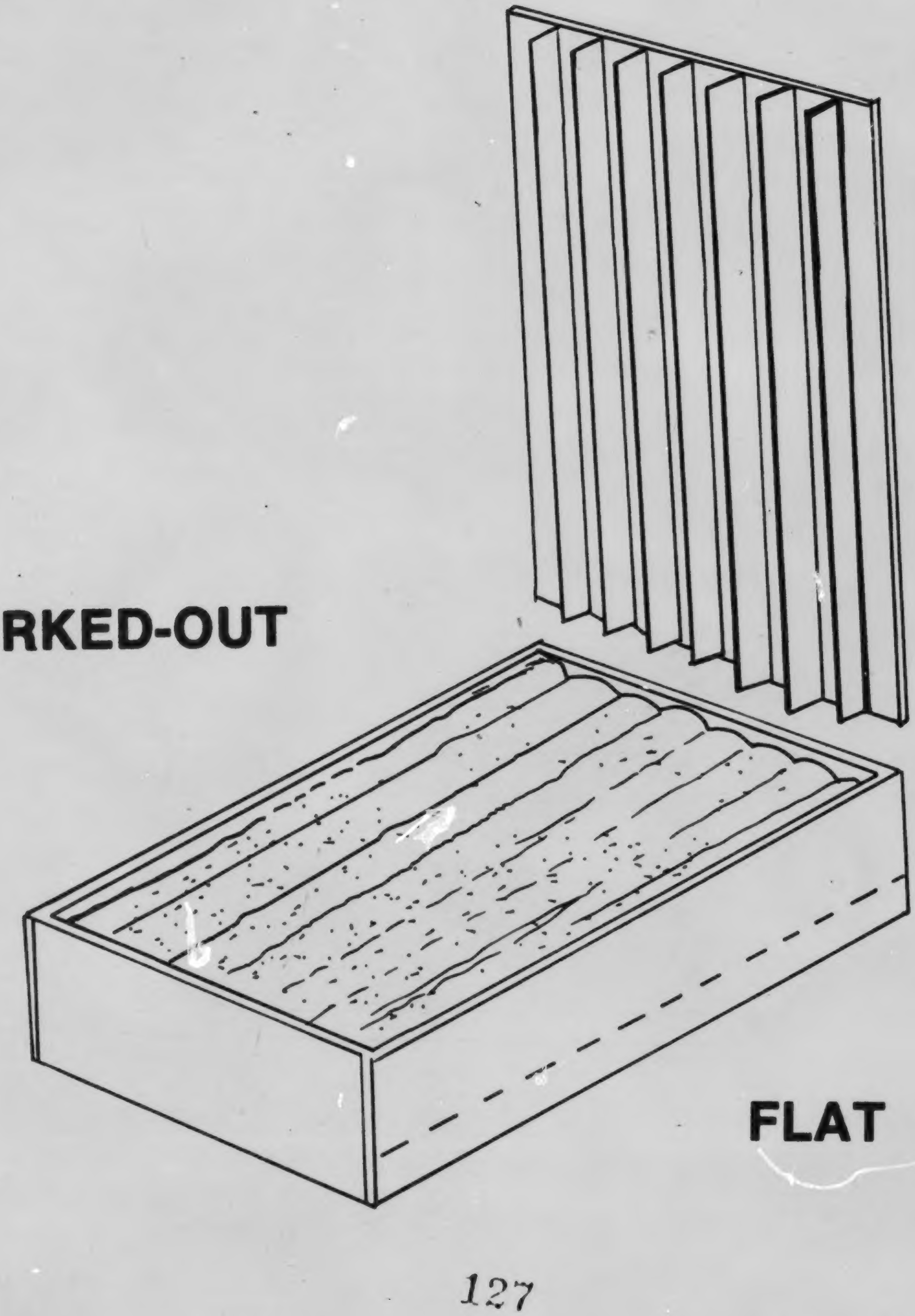
   F. Place seedlings in indirect light when they first appear

INFORMATION SHEET

XI. Care of newly emerged seedlings

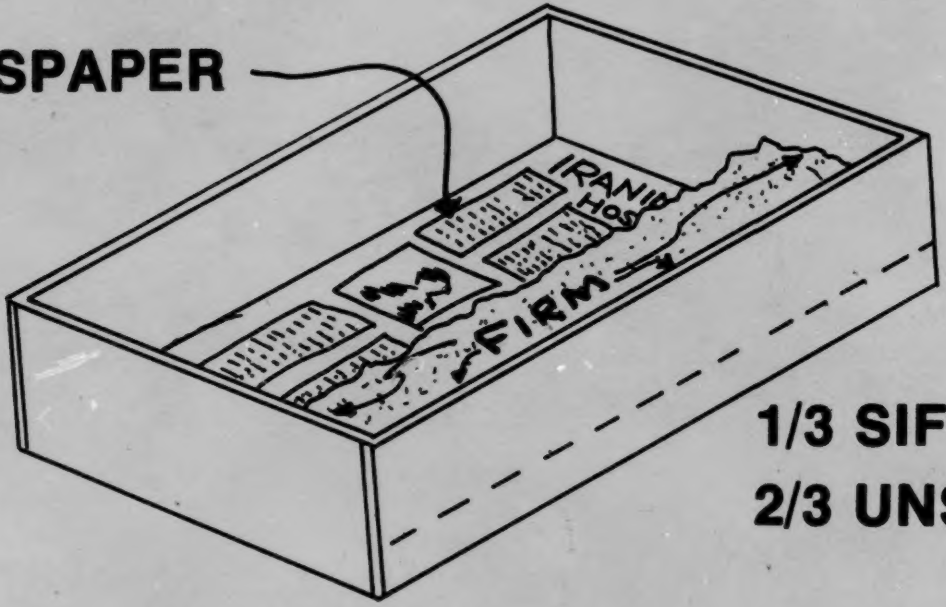
- A. After seedlings emerge, remove the pane of glass and the newspaper
- B. Stocky plants—Moderate to low temperatures
- C. Cool season plants
    1. 60-65° F daytime temperature
    2. 50-55° F nighttime temperature
- D. Warm season plants
    1. 70-75° F daytime temperature
    2. 60-65° F nighttime temperature
- E. Seedlings need fairly strong light but not direct sunlight
- F. Control watering

MARKING ROWS IN A FLAT


MARKED-OUT
FLAT

TM 1

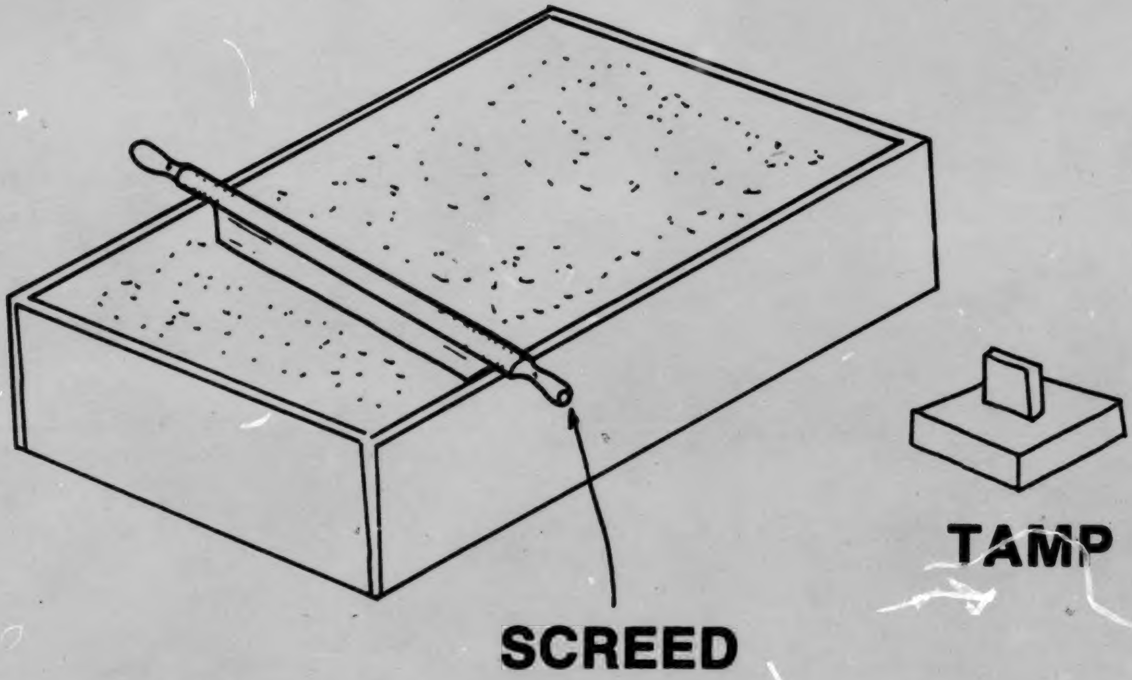
FILLING THE FLAT


IRANI
HOS
FIRM

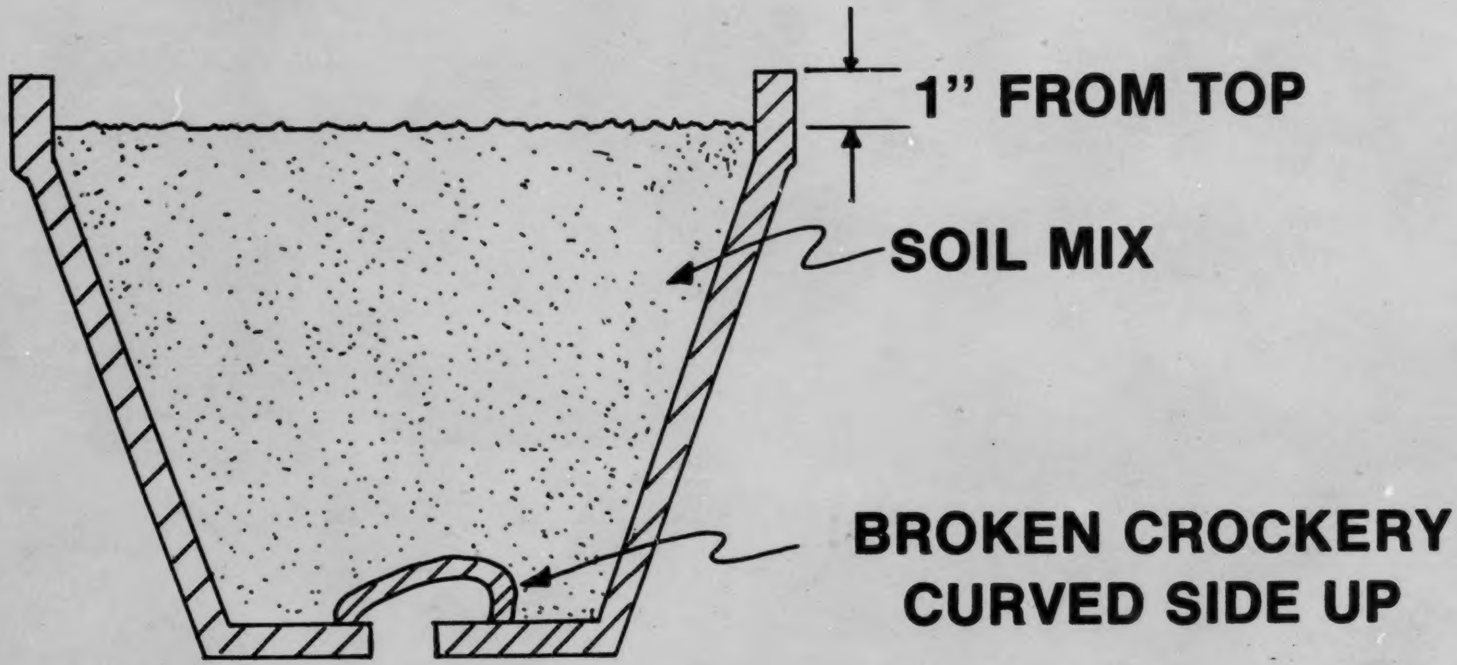
NEWSPAPER

1/3 SIFTED SOIL
2/3 UNSIFTED SOIL

USING THE SCREED AND TAMP

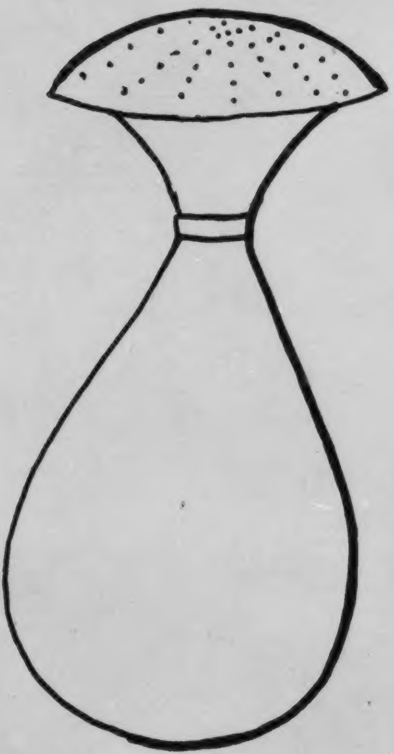

TAMP
SCREED

CROSS SECTION OF PREPARED POT

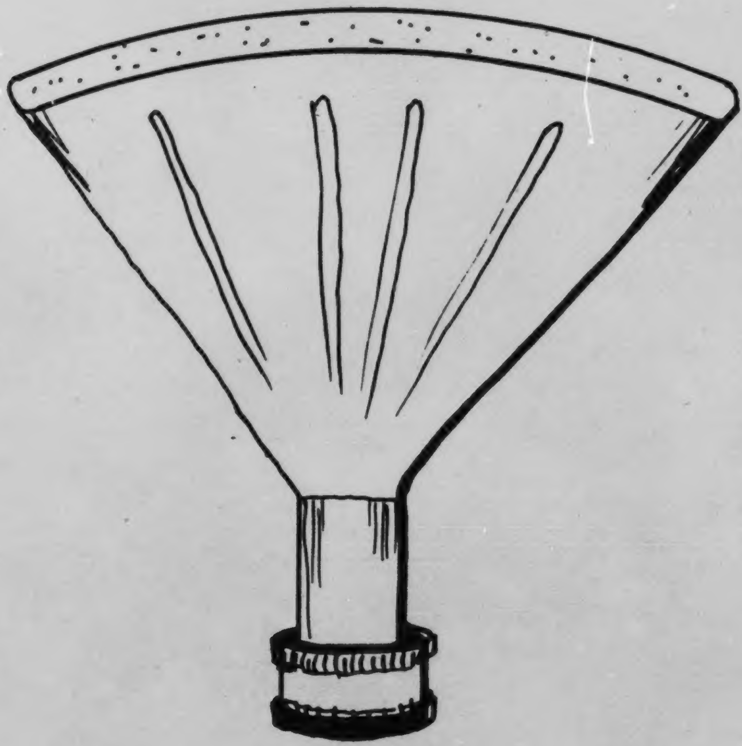

1" FROM TOP
SOIL MIX
BROKEN CROCKERY
CURVED SIDE UP

TOOLS TO MOISTEN SOIL

SYRINGE



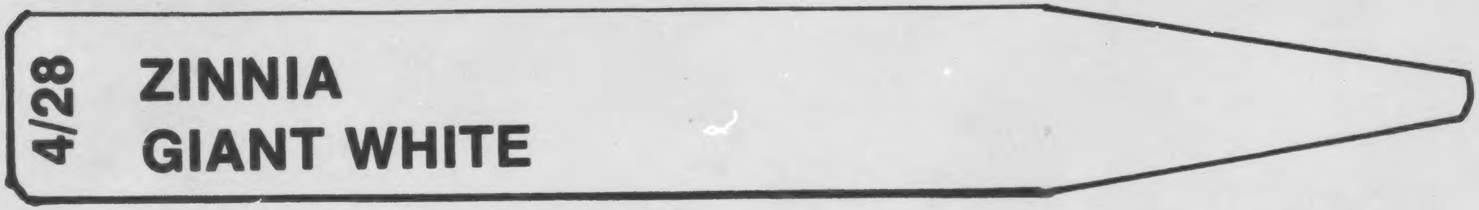
FAN SPRAY



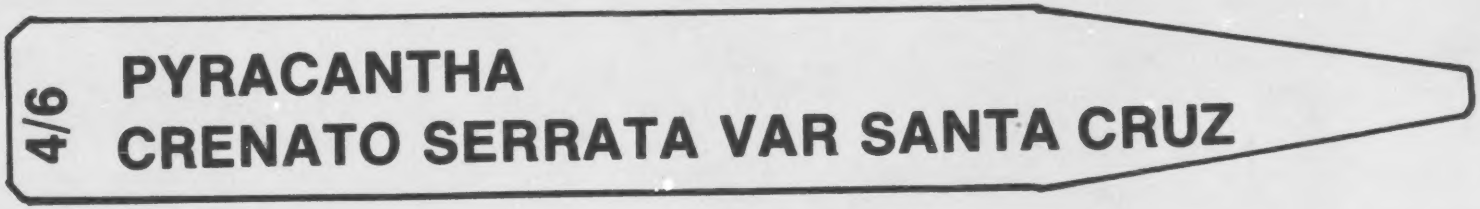
TM 5

H-151A

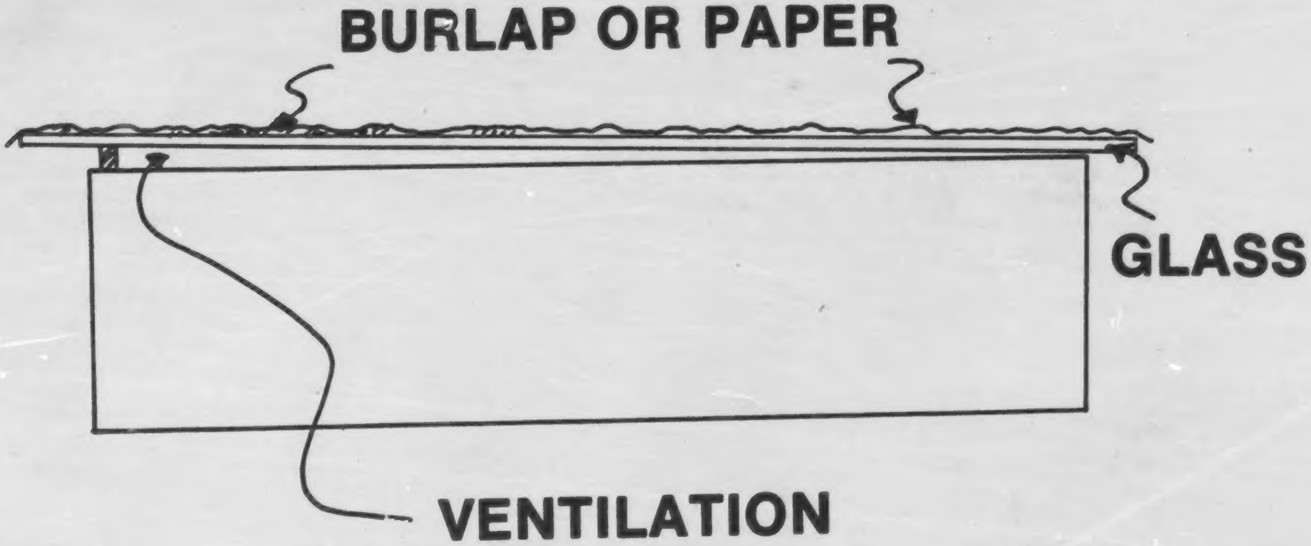
LABELING BEDDING PLANTS


4/28
ZINNIA
GIANT WHITE

LABELING TREES & SHRUBS


4/6
PYRACANTHA
CRENATO SERRATA VAR SANTA CRUZ

COVERING THE FLAT


BURLAP OR PAPER
GLASS
VENTILATION

STARTING PLANTS FROM SEED
UNIT VII

JOB SHEET #1—STARTING PLANTS FROM SEED IN FLATS

I. Materials

- A. One flat
- B. Germination medium
- C. Packet of marigold seeds
- D. One screed board
- E. One tamp

II. Procedure

- A. Place a single sheet of newspaper on bottom of flat
- B. Fill 2/3 full with soil mix
- C. Fill other 1/3 with sifted soil
- D. Firm soil around edges
- E. Use screed to remove excess soil
- F. Use tamp to press soil
- G. Mark out rows
- H. Separate seeds in rows

  (NOTE: Distance will depend on seed size.)
- I. Cover seeds
- J. Water newly planted seeds

STARTING PLANTS FROM SEED
UNIT VII

JOB SHEET #2—LABEL PLANTS

I. Equipment

  A. Grease pen

  B. Plastic labels

II. Procedure

  A. Determine the plant to be labeled

  B. Write the following on label

    1. Common name of plant

    2. Scientific name including genus, species, and variety

    3. Date of planting

    4. Name of person who is planting

  C. Place label in clear sight

STARTING PLANTS FROM SEED
UNIT VII

JOB SHEET #3—SOW SEEDS

I. Equipment

  A. Fresh garden seeds

  B. Identification labels

  C. Seed flat

  D. Media

  E. Wood block

  F. Water

II. Procedure

  A. Check seeds for freshness

  B. Prepare identification label

  C. Read seed sowing instructions

  D. Sow seed evenly in furrows or on surface

  E. Cover seed at recommended depth

  F. Firm soil with wood block

  G. Spray with fine mist of water

  H. Place I.D. labels

  I. Clean area

STARTING PLANTS FROM SEED
UNIT VII
TEST

1. Match the terms on the right to the correct definitions.

____ a. Watering system where water is allowed to filter upward through the soil

____ b. Small piece of wood used to smooth and pack soil in a flat

____ c. Compressed peat pellet enclosed in a thin net; one-seventh of its expanded size

____ d. Shallow tray made of wood, plastic, or metal used for germinating seeds

____ e. Small rubber bulb with a fine spray nozzle attached; used to water newly seeded crops

____ f. Pots made of 70% spagnum peat moss and 30% wood fiber which allow roots to grow through

____ g. Flat piece of wood with vertical pieces attached to one side; pressed down on soil to mark rows

____ h. Straight-edged piece of wood used to remove excess soil from flat

1. Syringe
2. Screed
3. Jiffy 7
4. Subirrigation
5. Flat
6. Jiffy pots
7. Tamp
8. Row marker

2. List the three basic kinds of containers used in propagating plants from seed.

a.

b.

c.

3. List in order the two steps in preparing the containers for planting.

a. Flats

1.

2.

b. Clay or plastic pots

1.

2.

4. Distinguish between the characteristics of peat moss based containers. Place a "P" in front of the characteristics of Jiffy-pots and a "7" in front of the characteristics of Jiffy-7's.

    ___ a. Combine functions of pot and potting soil into one unit

    ___ b. Seedlings may be transplanted into them

    ___ c. Porous walls permit good aeration

    ___ d. Inexpensive

    ___ e. Lightweight

    ___ f. Seeds started directly in them

    ___ g. Completely sterile and disease-free

    ___ h. Pot walls hold water and provide abundant, uniform supply

    ___ i. Cuttings may be rooted in them

5. List two reasons seeds remain dormant.

    a.

    b.

6. Select statements that are true regarding the planting of fine-sized and coarse-sized seeds by placing an "X" by the true statement.

    ___ a. Mix fine, moist sand with fine seeds to help keep seeds together when sowing

    ___ b. Separate fine seeds by a considerable distance

    ___ c. Gently tap seed packets to release small amounts into the rows

    ___ d. Place coarse seeds about 1" apart

    ___ e. Place ccarse seeds in rows one at a time

7. State the general rule for covering seed.

8. List four methods of watering newly sown crops.

a.
c.

b.
d.

9. Distinguish between information that should appear on seed flat labels for bedding plants (B) and shrubs and trees (ST). Place the proper letters in the correct blanks. A blank may have more than one correct answer.

___ a. Planting date

___ b. Common name and variety of plant

___ c. Species

___ d. Variety

___ e. Type and color

___ f. Sower's initials

___ g. Genus

10. Select from the following list true statements concerning the care of germinating seeds. Place an "X" in front of the true statements.

___ a. Place seed material in a cool place

___ b. Place seedlings in direct sunlight when they first appear

___ c. Lift the glass slightly on one side for ventilation

___ d. Cover the seed with burlap or paper

___ e. Place a pane of glass over the pot or flat

11. Describe factors to consider when caring for newly emerged seedlings.

12. Demonstrate the ability to:
    a. Start plants from seeds in flats.
    b. Label plants.
    c. Sow seeds.

STARTING PLANTS FROM SEED
UNIT VII

ANSWERS TO TEST

1. a. 4
   b. 7
   c. 3
   d. 5
   e. 1
   f. 6
   g. 8
   h. 2

2. a. Flats

   b. Clay or plastic pots

   c. Jiffy-pots or Jiffy-7

3. a. Flats

      1) Fill flat with soil

      2) Screed and tamp

   b. Clay or plastic pots

      1) Place a piece of broken pot over drain hole, curved side up

      2) Fill pots within one inch of top

4. a. 7
   b. 7
   c. p
   d. p
   e. p
   f. 7
   g. P
   h. P
   i. 7

5. a. Hard seed coats

   b. Dormant Embryos

6. b, c

7. Cover seeds to a depth 2-4 times their diameter

8. a. Fine spray syringe for fine seeds
   b. Hose and fine spray nozzle
   c. Subirrigation
   d. Newspaper over soil and covered with water

9. a. B, ST
   b. B
   c. ST
   d. St
   e. B
   f. B, ST
   g. ST

10. c, e

11. Description should include:
    a) After seedlings emerge, remove the pane of glass and the newspaper
    b) Stocky plants—moderate to low temperatures
    c) Cool season plants
       1) 60-65°F daytime temperature
       2) 50-55°F nighttime temperature
    d) Warm season plants
       1) 70-75°F daytime temperature
       2) 60-65°F nighttime temperature
    e) Seedlings need fairly strong light but not direct sunlight
    f) Control watering

12. Performance skills evaluated to satisfaction of instructor.

PLANT CLASSIFICATION
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the basic divisions of horticultural plants and distinguish between the various types of vegetables, fruits, flower and foliage plants, and nursery plants. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of the unit, the student should be able to:

1. Match terms associated with plant classification.
2. List the two basic divisions of horticultural plants.
3. List the two basic types of edible horticultural plants.
4. Select from a list types of vegetables grown for their edible aerial portions.
5. Select from a list types of vegetables grown for their edible underground portions.
6. Distinguish between the two types of deciduous fruits: small fruits and tree fruits.
7. Distinguish between the three types of tropical and subtropical fruits.
8. List two types of ornamental plants.
9. Classify flower and foliage plants as annual, biennial, or perennial.
10. List one example of each type of nursery plant.

PLANT CLASSIFICATION
UNIT VIII

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and assignment sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information and assignment sheets.

   E. Conduct field trip to local greenhouse.

   F. Provide examples of edible vegetables, both aerial and underground portions.

   G. Take test.

II. Student:

   A. Read objectives.

   B. Study information sheet and take notes.

   C. Complete assignment sheet and turn into instructor.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit

   A. Objective sheet

   B. Information sheets

   C. Assignment sheet—Classify Horticulture Plants

   D. Test

   E. Answers to test

II. References—Edmand, J. B.; Senn, T. L.; and Andrew, F. S. *Fundamentls of Horticulture.* New York, New York: McGraw Hill Book Company, Inc..

PLANT CLASSIFICATION
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

- A. Succulent—Plant with thickened, juicy stems or leaves, leaves, or both, which act as a reservor of moisture against a period of drought
- B. Herb—Seed plant with little or no woody fiber in its structure
- C. Herbacious—Herb-like plant
- D. Vine—Herbacious climbing plant
- E. Shrub—Woody plant with multiple stems arising from the root
- F. Deciduous—Plants which normally shed their leaves at a certain season
- G. Evergreen—Conifers and broad leaf plants that keep their foliage year around
- H. Annual—Plant that completes its life cycle in two growing seasons
- I. Biennial—Plant that completes its life cycle in two growing seasons
- J. Perennial—Plant that grows year after year and does not die after flowering
- K. Vegetable—Plant that is eaten cooked or raw during the principle part of the meal
- L. Fruit—Plant which forms a succulent fruit or related structure
- M. Ornamental—Plant grown normally for its beauty
- N. Flower—Plant grown primarily for its blossom
- O. Nursery plant—Plant grown for landscaping purposes
- P. Lawn—Expanse of closely clipped turf
- Q. Turf—Thick matting of low plants, mostly grasses
- R. Ground cover—Small plants which cover the soil in place of turf

II. Basic divisions of horticultural plants

- A. Edible plants
- B. Ornamental plants

INFORMATION SHEET

III. Edible plants

  A. Vegetables

    (NOTE: Both the aerial and underground portions of vegetables are grown to be eaten.)

  B. Fruits

    Examples: Deciduous, tropical, subtropical

IV. Vegetables grown for edible aerial portions

  A. Cold crops—cabbage, cauliflower, broccoli

  B. Legumes—Peas, beans, soybeans

  C. Solanaceous crops—Tomatoes, eggplant, pepper

  D. Vine crops—Cucumber, squash, melons

  E. Greens—Spinach, chard, dandelion

  F. Salad crops—Lettuce, celery, parsely, endive

  G. Miscellaneous—Corn, asparagus, okra, mushrooms

V. Vegetables grown for underground portions

  A. Root crops—Beet, carrot, radish, turnip, sweet potato

  B. Tubers and rootsocks—Potato, jerusalem artichoke, yam

  C. Bulbs and corms—Onion, garlic, shallot

VI. Deciduous fruits

  A. Small fruits—Cranberry, grape, raspberry, strawberry

  B. Tree fruits

    1. Pomes—Apple, pear, quince

    2. Stone fruits—Cherry, peach, plum, apricot

    3. Nuts—Peacan, walnut

INFORMATION SHEET

VII. Tropical and subtropical fruits

   A. Herbaceous perennials—Pineapple, banana

   B. Tree fruits

      1. Citrus—orange, lemon, grapefruit

      2. Miscellaneous—Fig, date, mango, avocado

   C. Nuts—Cashews, brazil nut, macadamia

VIII. Ornamental plants

   A. Flower and foliage plants

   B. Nursery plants

IX. Flowers and foliage plants

   A. Annuals—Petunia, zinnia, snapdragon

   B. Biennials—Evening primrose, hollyhock, sweet william

   C. Perennials—Tulip, peony, chrysanthemum, philodendron

X. Nursery plants

   A. Lawn plants—Bluegrass, bentgrass

   B. Ground cover—Periwinkle, sedum

   C. Vines (both herbaceous and woody)—Virginia creeper, grape, english ivy

   D. Shrubs (commonly restricted to deciduous shrubs)—Forsythia, lilac

   E. Evergreens (both shrubs and trees)—Spreading juniper, rhododendron, white pine

   F. Trees (commonly restricted to deciduous trees)—Pin oak, sugar maple, larch

PLANT CLASSIFICATION
UNIT VIII

ASSIGNMENT SHEET #1—CLASSIFY HORTICULTURE PLANTS

Using various plant and seed catalogs, select five pictures of each of the following: 1) vegetables grown for edible aerial portions, 2) vegetables grown for edible underground portions, 3) small fruits, 4) tree fruits, 5) flowering plants, 6) foliage plants, and 7) nursery plants. Classify them into vegetables, fruits, or ornamental plants.

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PLANT CLASSIFICATION
UNIT VIII

TEST

1. Match the terms on the right to the correct definitions.

____ a. Plant that completes its life cycle in two growing seasons

____ b. Plant that completes its life cycle in one growing season

____ c. Plant that grows year after year and does not die after flowering

____ d. Conifers and broad leaf plants that keep their foliage year-round

____ e. Plant that is eaten cooked or raw during the principle part of the meal

____ f. Plants which normally shed their leaves at a certain season

____ g. Plant which forms a succulent fruit or related structure

____ h. Woody plant with multiple stems arising from the root

____ i. Plant grown normally for its beauty

____ j. Herbacious climbing plant

____ k. Plant grown primarily for its blossom

____ l. Herb-like plant

____ m. Plant grown for landscaping purposes

____ n. Seed plant with little or no woody fiber in its structure

____ o. Expanse of closely clipped turf

____ p. Plant with thickened, juicy stems or leaves, leaves, or both, which act as a reservor of moisture against a period of drought

1. Succulent
2. Herb
3. Herbacious
4. Vine
5. Shrub
6. Deciduous
7. Evergreen
8. Annual
9. Biennial
10. Perennial
11. Vegetable
12. Fruit
13. Ornamental
14. Flower
15. Nursery plant
16. Lawn
17. Turf
18. Ground cover

____ q. Small plants which cover the soil in place to turf

r. Thick matting of low plants, mostly grasses

2. List the two basic divisions of horticultural plants.

   a.

   b.

3. List two basic types of edible horticultural plants.

   a.

   b.

4. Select from the list below types of vegetables grown for their edible areial portions. Place an "x" in front of the correct answers.

   ____ a. Cucumber

   ____ b. Lettuce

   ____ c. Beets

   ____ d. Tomatoes

   ____ e. Potatoes

   ____ f. Apples

   ____ g. Legumes

   ____ h. Greens

   ____ i. Yam

   ____ j. Grapes

   ____ k. Corn

   ____ l. Okra

   ____ m. Vine crops

   ____ n. Peas

   ____ o. Onions

   ____ p. Broccoli

5. Select from a list below types of vegetables grown for their edible underground protions. Place an "x" in the correct blanks.

____ a. Cauliflower

____ b. Carrots

____ c. Radishes

____ d. Grapes

____ e. Jerusalem artichoke

____ f. Onion

____ g. Lemon

____ h. Apricot

6. Distinguish between the types of deciduous fruits by placing an "s" for small fruits and a "t" for tree fruits in the correct blanks.

____ a. Cranberry

____ b. Grapes

____ c. Apple

____ d. Pecan

____ e. Peach

____ f. Raspberry

____ g. Pear

____ h. Walnut

____ i. Strawberry

____ j. Cherry

7. Distinguish between the three types of tropical and subtropical fruits. Place an "H" for herbaceous perennials, a "T" for tree fruits, and an "N" for nuts in the correct blanks.

____ a. Cashew

____ b. Pineapple

____ c. Banana

____ d. Lemon

___ e. Fig

___ f. Grapefruit

___ g. Macadamia

___ h. Mango

___ i. Orange

___ j. Avocado

8. List two types of ornamental plants.

a.

b.

9. Classify the following flower and foliage plants as annual (A), biennial (B), or perennial (P). Place the correct letter in the blanks provided.

___ a. Evening primrose

___ b. Zinnia

___ c. Snapdragon

___ d. Tulip

___ e. Hollyhock

___ f. Peony

___ g. Petunia

10. Name one example of each type of nursery plant given below.

a. Lawn plants—

b. Ground cover—

c. Vines (both herbaceous and woody)—

d. Shrubs (commonly restricted to deciduous shrubs)—

e. Evergreens (both shrubs and trees)—

f. Trees (commonly restricted to deciduous trees)—

H-189-A

PLANT CLASSIFICATION
UNIT VIII

ANSWERS TO TEST

1. a. 9
   b. 8
   c. 10
   d. 7
   e. 11
   f. 6
   g. 12
   h. 5
   i. 13
   j. 4
   k. 14
   l. 3
   m. 15
   n. 2
   o. 16
   p. 1
   q. 18
   r. 17

2. a. Edible plants

   b. Ornamental plants

3. a. Vegetables

   b. Fruits

4. a,b,d,g,h,k,l,m,n,p

5. b,c,e,f

6. a. S
   b. S
   c. T
   d. T
   e. T
   f. S
   g. T
   h. T
   i. S
   j. T

7. a. N
   b. H
   c. H
   d. T
   e. T
   f. T
   g. N
   h. T
   i. T
   j. T

8. a. Flowers and foliage plants

   b. Nursery plants

9. a. B
   b. A
   c. A
   d. P
   e. B
   f. P
   g. A

10. Any one example under each of the following:

    a. Lawn plants—Bluegrass, bentgrass

    b. Ground cover—Periwinkle, sedum

    c. Vines (both herbaceous and woody)—Virginia creeper, grape, english ivy

    d. Shrubs (commonly restricted to deciduous shrubs)—Forsythia, lilac

    e. Evergreens (both shrubs and trees)—Spreading juniper, rhododendron, white pine

    f. Trees (commonly restricted to deciduous trees)—Pinoak, sugar maple, larch

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to name or identify major parts of plants; to demonstrate knowledge of the major functions of each part; and to demonstrate familiarity with terminology that relates to plant parts. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the students should be able to:

1. Match the terms associated with the structure and function of plant parts to the correct definitions.
2. Match the four basic plant parts with the correct functions of each part.
3. Match the three major specialized plant tissues with their functions.
4. Identify four types of roots.
5. Match types of roots to their functions.
6. List four characteristics of root hairs.
7. State the major function of all stems.
8. Match the seven major types of stems with the correct descriptions.
9. Match leaf tissues with their functions.
10. Match names of modified leaves with their functions.
11. Identify the parts of a flower.
12. Match names of the basic parts of a flower with their functions.
13. Distinguish between a complete and an incomplete flower.
14. Distinguish between monocot and dicot plants.

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX

SUGGESTED ACTIVITIES

I. **Instructor:**

- A. **Provide students with objective sheet.**
- B. **Provide students with information and assignment sheets.**
- C. **Make transparencies.**
- D. **Discuss unit and specific objectives.**
- E. **Discuss information and assignment sheets.**
- F. **Give test.**

II. **Students:**

- A. **Read objectives.**
- B. **Study information sheets.**
- C. **Complete assignment sheets and turn into instructor.**
- D. **Take test.**

INSTRUCTIONAL MATERIALS

I. **Included in this unit:**

- A. **Objective sheet**
- B. **Information sheets**
- C. **Transparency masters**
    1. **TM 1—Parts of a Plant**
    2. **TM 2—Types of Roots**
    3. **TM 3—Flower Parts**
    4. **TM 4—Section of a Leaf**
- D. **Assignment sheets**
    1. **Assignment sheet #1—Complete Table on Plant Parts**

2. Assignment Sheet #2—Terms Related to Plant Parts

E. Answers to assignment sheets

F. Test

G. Answers to test

II. References:

A. Hartman, H. T., and Kester, D. E. *Plant Propagation: Principles and Practices:* Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1974.

B. *Garden Seed Product Information Manual* Downers Grove, Illinois: Vaughn's Seed Company, 1974.

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX

INFORMATION SHEET

I. Terms and definitions

A. Apetalous—Flower with no petals

B. Bracts—Modified leaves that sometimes take the place of petals

C. Chlorophyll—Green vegetable pigment of plants essential in the process of photosynthesis

D. Dicot—Plant that produces two seed leaves

Example: Bean

E. Epidermis—Covering layer usually one cell thick; found on the surfaces of all plant parts

F. Monocot—Plant that produces one seed leaf

Example: Corn

G. Petiole—Slender stalk by which a leaf is attached to a stem

H. Photosynthesis—Process by which plants form carbohydrates from interaction of carbon dioxide (Co_2), water (H_2O), sunlight, and chlorophyll

I. Pistillate—Flower with functional pistil and nonfunctional stamens

J. Respiration--Process of taking in oxygen (O_2), giving off carbon dioxide ($C0_2$), and providing energy

K. Scales—Modified leaf; hard, layered covering to protect buds in winter

L. Staminate—Flower with functional stamen and nonfunctional pistil

M. Stomate—Opening in epidermis of leaf through which gases, carbon dioxide, oxygen, and water vapor enter and exit the plant

N. Tendril—Modified leaf; slender, threadlike structures that twine

O. Transpiration—Loss of water vapor through the leaves

II. Basic plant parts and functions (Transparency 1)

A. Root

1. Absorbs water and minerals from soil

INFORMATION SHEET

2. Stores food

3. Anchors plants

4. Conduction

B. Stem

1. Supports leaves and displays them to light

2. Aids in manufacturing food

3. Stores food

4. Where photosynthesis takes place

5. Conduction

C. Leaf

1. Manufactures food for plant through photosynthesis

2. Where transpiration takes place

3. Exchanges gases with atmosphere in process of respiration and photosynthesis

D. Flower

1. Contains organs specialized for sexual reproduction

2. Produces seed and fruit

III. Specialized plant tissues and functions

A. Cambium

1. Cells responsible for growth of plant in diameter

2. Found in roots and stems

3. Cells divide rapidly which is important in budding and grafting

B. Phloem

1. Complex tissue (bark) made of cells that transport food from the manufacturing cells

2. Transports manufactured foods downward from leaves to stem and roots

INFORMATION SHEET

3. Protected by corky tissue

4. Phloem plus corky tissue constitute bark

C. Xylem

1. Complex tissue (wood) made of cells that transport water and raw materials to manufacturing cells and give rigidity to stem

2. Complex tissue, such as wood

3. Transports water and essential raw materials upward from roots to stem and leaves

4. Gives rigidity to stems

5. Account for annual rings

(NOTE: In spring wood, the xylem large cells with thinner walls thus it appears lighter colored and less dense than summer wood.)

IV. Types of roots (Transparency 2)

A. Fibrous

B. Taproot

C. Aerial

D. Adventurous

E. Aquatic

V. Types and functions of roots (Transparency 2)

A. Taproot

Example: Carrot

1. Continuation of primary root

2. Ideal for anchorage

3. Reaches water deeper in ground than fibrous roots

4. Is thick and fleshy and serves as an underground storehouse

B. Fibrous root

Example: Grass

1. Primary root surpassed by the growth of its branches or secondary roots

INFORMATION SHEET

2. Usually shallow; spread through a large area of soil
3. Absorb water and minerals efficiently
4. Anchors soil particles from erosion

C. Aerial roots

1. Anchoring air roots—Very short roots that grow out horizontally from stem and fasten plant to a support
   Examples: English ivy, Boston ivy, Virginia creeper
2. Absorptive air roots—Must have thick outer covering of dead tissue that absorbs and stores water
   Example: Tropical orchids

D. Aquatic roots—Have the ability to absorb oxygen and minerals from the water

Example: Water lillies

E. Adventitious roots—Roots that arise from places other than the primary root

Example: Roots on a rooted cutting

VI. Characteristics of root hairs

A. Slender tubular extension of the outermost cells of the root, each one representing a single cell

B. Found primarily on the part of the root where vascular tissue has not yet formed or is just beginning to form

C. Aid in absorption of water and raw materials

D. Are easily damaged and short lived

VII. Major function of all stems—Leaf support, food storage, and propagation

VIII. Types of stems

A. Corm—Bulb-like, solid, fleshy, scale-covered enlargement, usually of the underground stem

B. Bulb—Any of several underground stems that are comprised of a cluster of thickened, scale-like leaves

C. Tuber—Short, thickened portion of an underground stem

D. Crown—Portion of the stem just above and below the ground line
Examples: Strawberries and asparagus

INFORMATION SHEET

E. Spurs—Compressed stems of woody plants adapted for fruit production

Example: Pears

F. Rhizome—Stem that grows under the soil surface; like a root; has well developed nodes and internodes

G. Stolon—Stem that grows horizontally above soil surface

Example: Bermude grass, Zoysia grass

IX. Principal leaf tissues and functions (Transparency 3)

A. Epidermis—Covering layer usually one cell thick; found on surfaces of all plant parts; consists of protective cells, guard cells, and stomates

B. Mesophyll—Tissue containing two types of chlorophyll cells: elongated (palesade) and round (spongy); food manufacturing region of the leaf

C. Veins—Channels in the tissue; help to support leaf

X. Modified leaves and functions

A. Scales—Protection of wood plants during winter

B. Bracts—Leafy (as in dogwood or pointsettia) or fleshy (as in globe artichoke)

1. Leafy bracts—Help promote propagation by attracting pollen bearers

2. Fleshy bracts—Store nourishment for the plant seed

C. Tendrils—Slender, threadlike structures that can twine; support plant

Example: Upper leaflets of a garden pea

D. Thorns—Protect from predators

Example: Cacti

INFORMATION SHEET

E. Sacs—Hold water and catch insects

Example: Pitcher plant, sundews, Venus fly-trap

XI. Parts of a flower (Transparency 3)

A. Pistil

B. Petal

C. Stigma

D. Style

E. Ovary

F. Receptacle

G. Sepal

H. Anther

I. Filament

J. Stamen

XII. Parts of a flower and functions (Transparency 4)

A. Sepal—Protects stamen and pistils in bud stage

(NOTE: Many sepals together are called a calyx.)

B. Petal

(NOTE: Many petals together are called a "corolla.")

1. Protects stamens and pistils in bud stage
2. Attracts pollen bearers by color

C. Stamen—Produces pollen which, in time, contains sperm

(NOTE: The stamen consists of a stalk called a "filament" and a pollen sac called an "anther." The stamen is the male organ of the flower.)

INFORMATION SHEET

D. Pistil—Consists of large portion at base (ovary), flattened portion at apex (stigma), and connecting tissue between ovary an stigma (style)

(NOTE: The pistil is known as the female organ of the flower.)

1. Function of ovary—Produces ovules which will develop into seeds when fertilized
2. Function of stigma—Catches and holds pollen; has sticky surface
3. Function of style—Connects ovary and stigma

XIII. Complete and incomplete flowers

A. Complete flower—Has all four of the main parts of a flower: sepals, petals, stamens, and pistils

B. Incomplete flower—Does not have all four of the main parts of a flower

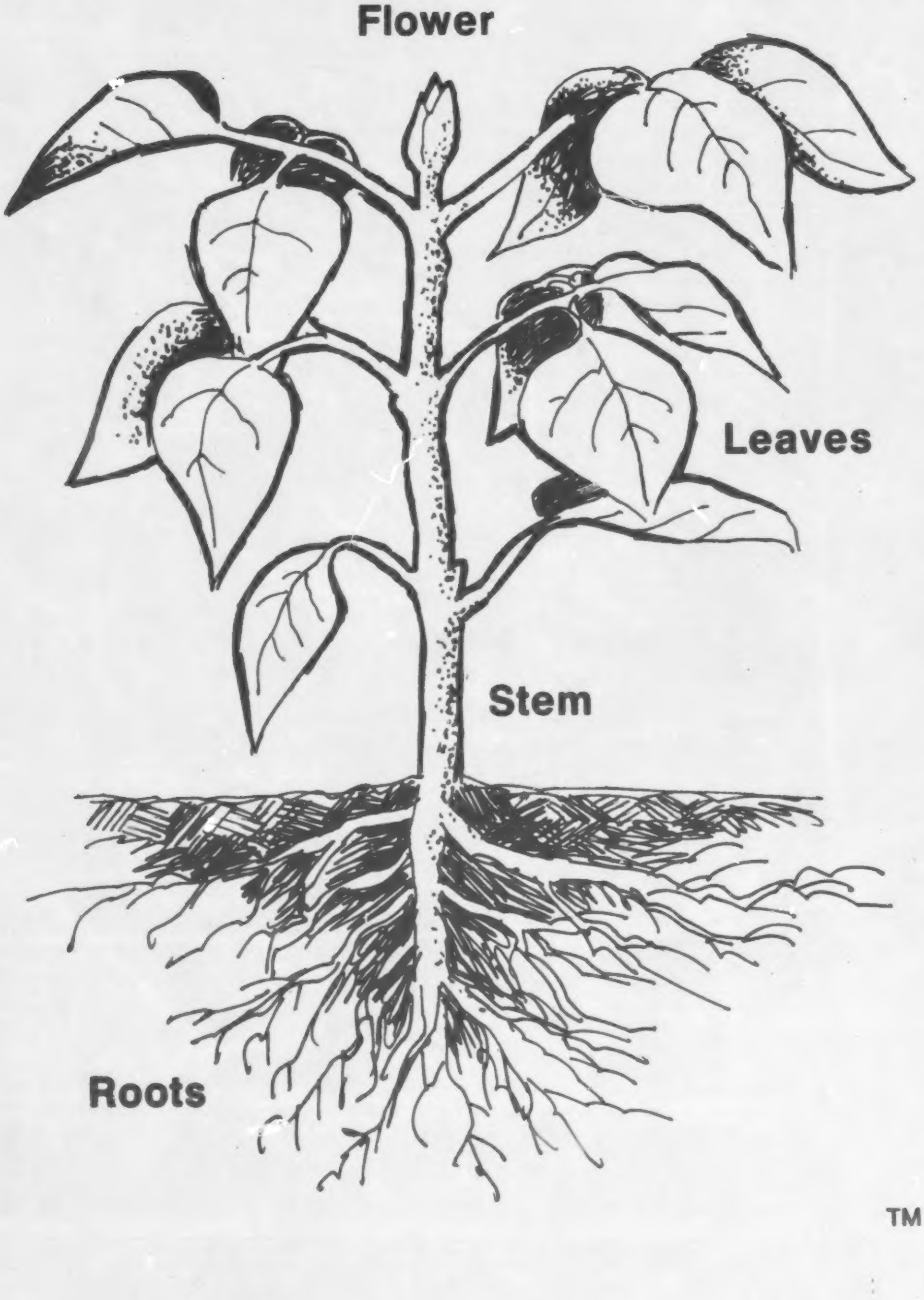
Examples: Apetalous, staminate, pistillate

XIV. Types of seedling plants

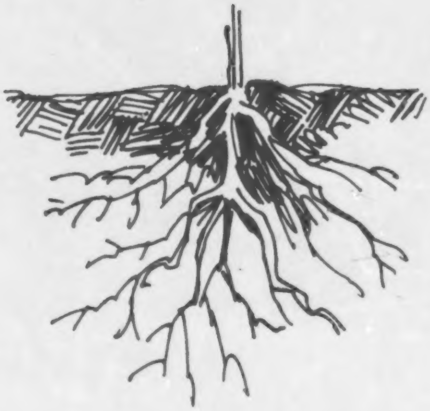
A. Monocot—Plant that produces one seed leaf, such as palms, orchids, lillies, and grasses

B. Dicot—Plant that produces two seed leaves, such as most flowering plants, including deciduous trees, herbs, and shrubs

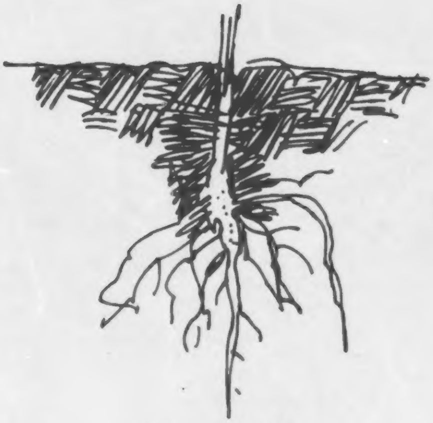
Parts of a Plant


Flower
Leaves
Stem
Roots

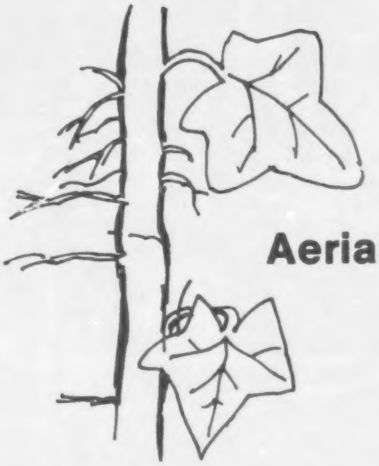
Types of Roots



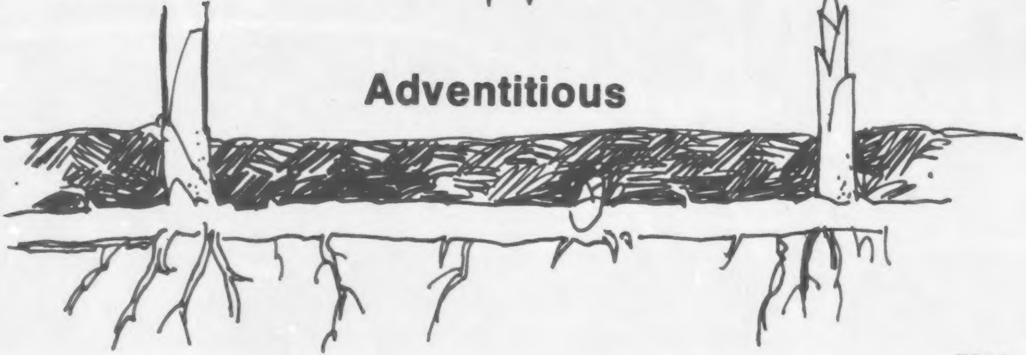
Fibrous



Taproot



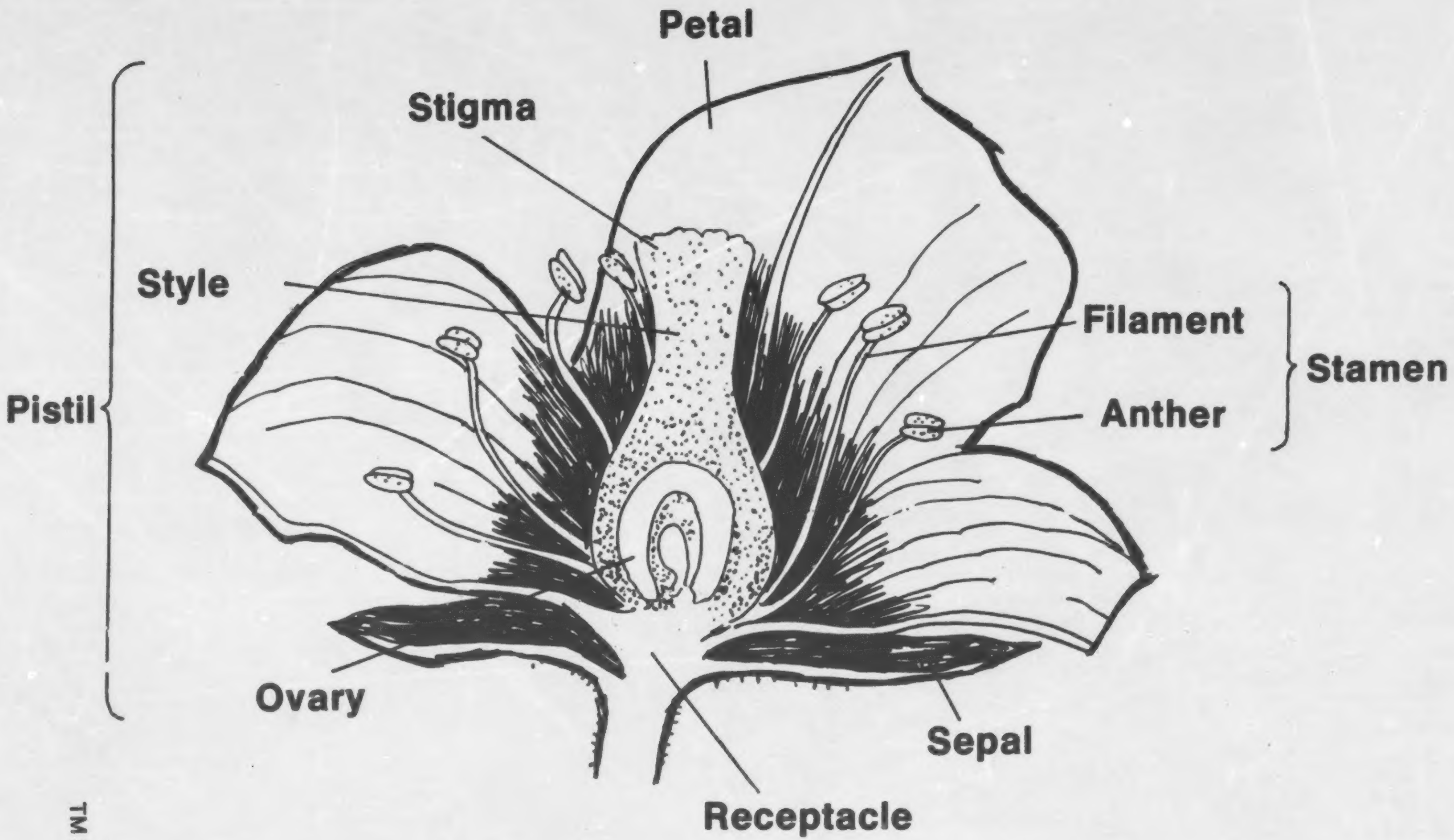
Aerial



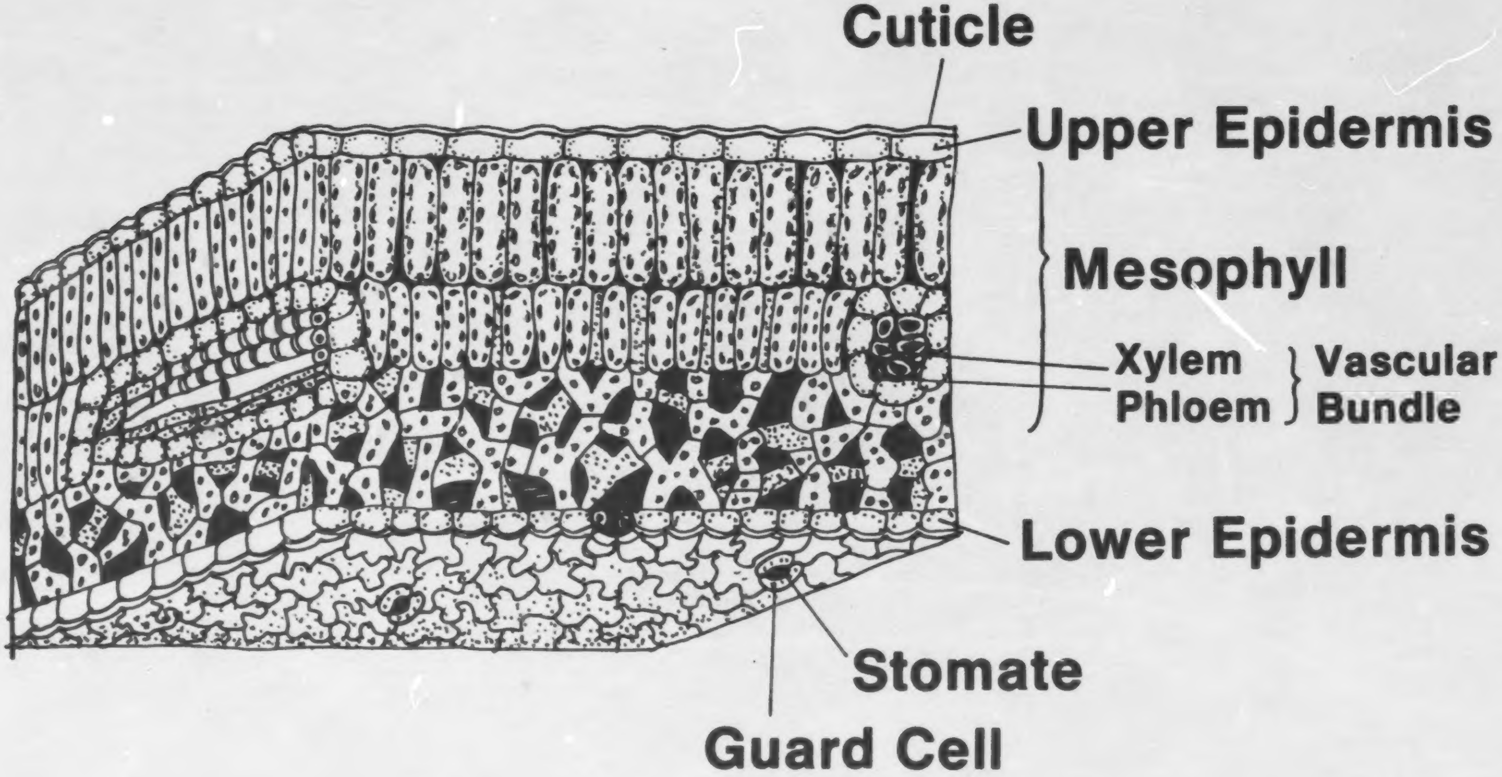
Adventitious

TM 2

Flower Parts


Petal
Stigma
Style
Pistil
Filament
Stamen
Anther
Ovary
Sepal
Receptacle

Section of a Leaf


Cuticle
Upper Epidermis
Mesophyll
Xylem
Phloem
Vascular Bundle
Lower Epidermis
Stomate
Guard Cell

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX

ASSIGNMENT SHEET #1—COMPLETE TABLE ON PLANT PARTS

Fill in the table below with basic information from this unit.

TABLE OF PLANT PARTS

	PLANT PART NAMES	FUNCTIONS
ROOT		
STEM	Above-ground Stems	
	Underground Stems	
	Above-and-Below-Ground	
LEAF		
FLOWER		

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX

ASSIGNMENT SHEET #2—Terms Related to Plant Parts

Fill in the terms found in this unit that relate to these basic plant parts.

A. Root terms

1.
2.
3.
4.
5.
6.
7.

B. Stem terms

1.
2.
3.
4.
5.
6.
7.
8.

C. Leaf terms

1.
2.
3.
4.
5.
6.
7.
8.

D. Flower terms

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX
ANSWER TO ASSIGNMENT SHEETS

Assignment Sheet #1

	PLANT PART NAMES	FUNCTIONS
ROOT	Tap Fibrous Aerial	Anchors root Stores food Absorbs water and minerals
STEM	Above-ground Stems Crown Spur Stolon	Supports leaves Stores food Aids in manufacturing food for plant
	Underground Stems Corm Bulb Tuber	
	Above-and-Below-Ground Rhizome	
LEAF	Epidermis Palisade Cells Stomates & Guard Cells	Manufactures food by photosynthesis Aids water evaporation
FLOWER	Sepal Petal Stamen Pistil	Produces seed Means of Reproduction

Assignment Sheet #2

A. Root terms

1. Tap root
2. Fibrous root
3. Fleshy root
4. Primary root
5. Aerial root
6. Adventitious root
7. Root hairs

B. Stem Terms

1. Primary stem
2. Rhizome
3. Stolon
4. Tuber
5. Bulb
6. Corm
7. Crown
8. Spur

C. Leaf Terms

1. Epidermis
2. Veins
3. Stomates
4. Guard cells
5. Chlorophyll
6. Scales
7. Bracts
8. Tendrils

D. Flower Terms

1. Sepal
2. Calyx
3. Corolla
4. Stamen
5. Anther
6. Filament
7. Pistil
8. Stigma
9. Style
10. Ovary
11. Complete flower
12. Incomplete flower
13. Pistillate flower
14. Staminate flower
15. Apetalous flower
16. Pollen
17. Petals

(Any order is correct)

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX

TEST

1. Match terms on the right to the correct definitions.

____ a. Loss of water vapor through the leaves

____ b. Flower with no petals

____ c. Modified leaf; hard, layered covering to protect buds in winter

____ d. Modified leaf; slender, threadlike structures that twine

____ e. Modified leaves that sometimes take the place of petals

____ f. Process by which plants form carbohydrates from interaction of carbon dioxide (CO_2), water (H_2O), sunlight, and chlorophyll

____ g. Process of taking in oxygen (O_2), giving off carbon dioxide (CO_2), and providing energy

____ h. Flower with functional pistil and nonfunctional stamen

____ i. Plant that produces two seed leaves

____ j. Covering layer usually one cell thick; found on the surfaces of all plant parts

____ k. Plant that produces one seed leaf

____ l. Opening in epidermis of leaf through which gases, carbon dioxide, oxygen, and water vapor enter and exit the plant

____ m. Green vegetable pigment of plants essential in the process of photosynthesis

____ n. Slender stalk by which a leaf is attached to a stem

____ o. Flower with functional stamen and nonfunctional pistil

1. Apetalous
2. Bracts
3. Chlorophyll
4. Dicot
5. Epidermis
6. Monocot
7. Petiole
8. Photosynthesis
9. Pistillate
10. Respiration
11. Scales
12. Staminate
13. Stomate
14. Tendril
15. Transpiration

2. Match the four basic plant parts on the right with the correct functions of each part. An answer may be used more than once and a blank may have more than one correct answer.

____ a. Where transpiration takes place

____ b. Contains organs specialized for sexual reproduction

____ c. Where photosynthesis takes place

____ d. Absorbs water and minerals from soil

____ e. Stores food

____ f. Aids in manufacturing food

____ g. Conduction

____ h. Produces seed and fruit

1. Root
2. Stem
3. Leaf
4. Flower

3. Match the three major specialized plant tissues to their correct functions.

____ a. Transports manufactured foods downward from leaves to stem and roots

____ b. Transports water and essential raw materials upward from roots to stem and leaves

____ c. Cells responsible for growth of plant in diameter

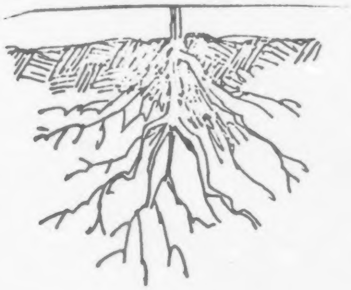
____ d. Found in roots and stems

____ e. Protected by corky tissue

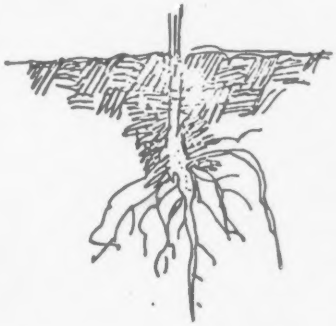
____ f. Gives rigidity to stems

1. Cambium
2. Phloem
3. Xylem

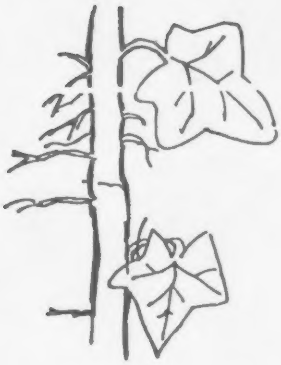
4. Identify the following types of roots.

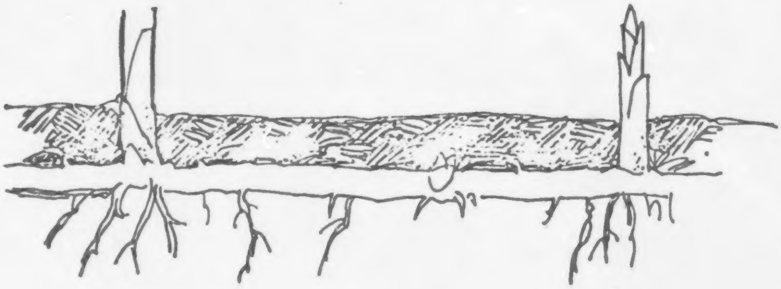


a. ______________________________



b. ______________________________





c. ______________________________ d. ______________________________

5. Match the types of roots on the right to their correct functions.

____ a. Roots that arise from places other than the primary root

____ b. Very short roots that grow out horizontally from stem and fasten plant to a support

____ c. Continuation of primary root

____ d. Absorb water and mineral efficiently

____ e. Have the ability to absorb oxygen and minerals from the water

____ f. Primary root surpassed by the growth of its branches or secondary roots

____ g. Is thick and fleshy and serves as an underground storehouse

1. Adventitious roots
2. Aquatic roots
3. Absorptive air roots
4. Anchoring air roots
5. Fibrous roots
6. Taproots

6. List four characteristics of root hairs.

a.

b.

c.

d.

7. State the major function of all stems.

8. Match the major types of stems on the right with the correct descriptions.

a. Any of several underground stems that are comprised of a cluster of thickened, scale-like leaves

____ b. Compressed stems of woody plants adapted for fruit production

____ c. Short, thickened portion of an underground stem

____ d. Bulb-like, solid, fleshy, scalecovered enlargement, usually of the underground stem

____ e. Portion of the stem just above and below the ground line

____ f. Stem that grows horizontally above soil surface

____ g. Stem that grows under the soil surface; like a root; has well developed nodes and internodes

1. Corm
2. Bulb
3. Tuber
4. Crown
5. Spurs
6. Rhizome
7. Stolon

9. Match leaf tissues on the right with their functions.

____ a. Covering layer usually in cell thick; found on surfaces of all plant parts; consists of protective cells, guard cells, and stomates

____ b. Tissue containing two types of chlorophyll cells: elongated (palisade) and round (spongy); food manufacturing region of the leaf

____ c. Channels in the tissue; help to support leaf

1. Epidermis
2. Mesophyll
3. Veins

10. Match the names of modified leaves on the right with their function.

____ a. Hold water and catch insects

____ b. Help promote propagation by attracting pollen bearers

____ c. Protection of wood plants during winter

____ d. Slender, threadlike structure that can twine; support plant

____ e. Store nourishment for the plant seed

____ f. Protect from predetors

1. Scales
2. Leafy bracts
3. Tendrils
4. Thorns
5. Sacs
6. Fleshy bracts

11. Identify the parts of the below flower.

a. ______________________

b. ______________________

c. ______________________

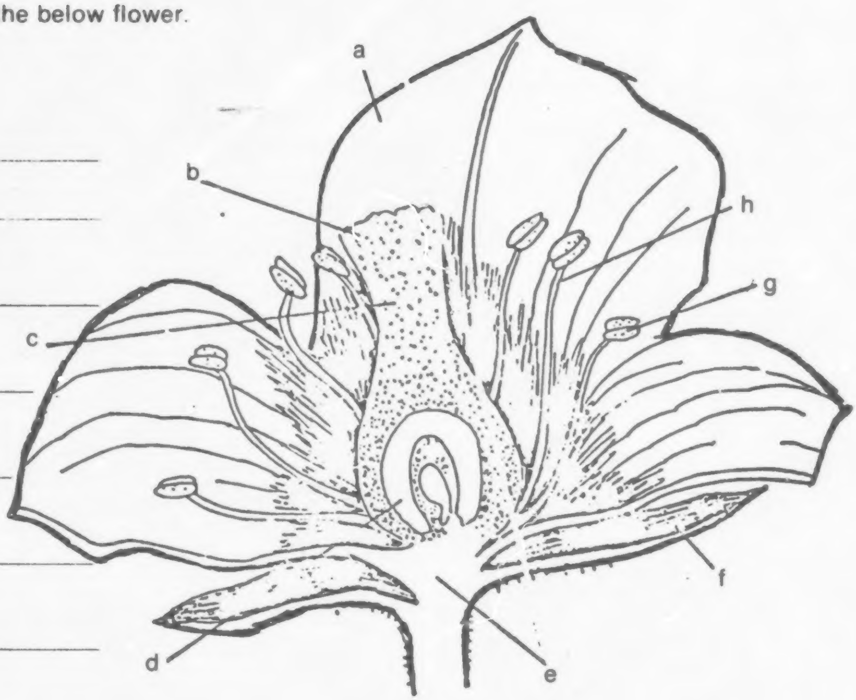
d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________



12. Match names of the basic parts of a flower on the right with their functions.

___ a. Produces pollen which, in time, contains semen	1. Sepal
___ b. Protects stamens and pistils in bud stage; attracts pollen bearers by high color	2. Petal
___ c. Catches and holds pollen; has sticky surface	3. Stamen
___ d. Connects ovary and stigma	4. Pistil
___ e. Consists of large portion at base (ovary), flattened portion at apex (stigma), and connecting tissue between ovary and stigma (style)	5. Ovary
___ f. Protects stamen and pistils in bud stage	6. Stigma
___ g. Produces ovules which will develop into seeds when fertilized	7. Style

13. Distinguish between incomplete and complete flowers by placing an "I" for incomplete and a "C" for complete flower.

    ____ a. Has all four of the main parts of a flower: sepals, petals, stamens, and pistils

    ____ b. Does not have all four of the main parts of a flower

14. Distinguish between a monocot and dicot plants by placing a "D" for dicot and "M" for monocot.

    ____ a. Plant that produces two seed leaves, such as most flowering plants, including deciduous trees, herbs, and shrubs

    ____ b. Plant that produces one seed leaf, such as palms orchids, lillies, and grasses

PLANT PARTS: STRUCTURE AND FUNCTION
UNIT IX
ANSWERS TO TEST

1. a. 15
   b. 1
   c. 11
   d. 14
   e. 2
   f. 8
   g. 10
   h. 9
   i. 4
   j. 5
   k. 6
   l. 13
   m. 3
   n. 7
   o. 12

2. a. 3
   b. 4
   c. 2
   d. 1
   e. 1,2
   f. 2
   g. 1,2
   h. 4

3. a. 2
   b. 3
   c. 1
   d. 1
   e. 2
   f. 3

4. a. Fibrous

   b. Taproot

   c. Aerial

   d. Adventurous

5. a. 1
   b. 4
   c. 6
   d. 5
   e. 2
   f. 5
   g. 6

6. a. Slender, tubular extension of the outermost cells of the root, each one representing a single cell

   b. Found primarily on the part of the root where vascular tissue has not yet formed or is just beginning to form

   c. Aid in absorption of water and raw materials

   d. Are easily damaged and short lived

7. Leaf support, food storage, and propagation

8. a. 2
   b. 5
   c. 3
   d. 1
   e. 4
   f. 7
   g. 6

9. a. 1
   b. 2
   c. 3

10. a. 5
    b. 2
    c. 1
    d. 3
    e. 6
    f. 4

11. a. Petal
    b. Stigma
    c. Style
    d. Ovary
    e. Receptacle
    f. Sepal
    g. Anther
    h. Filament

12. a. 3
    b. 2
    c. 6
    d. 7
    e. 4
    f. 1
    g. 5

13. a. C

    b. I

14. a. D

    b. M

PLANT GROWTH AND DEVELOPMENT
UNIT X

UNIT OBJECTIVE

After completion of this unit, the student should be able to state the formulas for photosynthesis and respiration and list the imputs and products of photosynthesis. The student should also be able to demonstrate oxygen production by photosynthesis and the respiration process. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After the completion of this unit, the student should be able to:

1. Match terms associated with plant growth and development with the correct definitions.
2. State the photosynthesis formula using chemical symbols.
3. List three inputs of photosynthesis.
4. List three products of photosynthesis.
5. State the optimum temperature range for photosynthesis.
6. State the formula for respiration using chemical symbols.
7. Name three primary factors affecting respiration.
8. Demonstrate oxygen production by photosynthesis in elodea.
9. Demonstrate the respiration process.

PLANT GROWTH AND DEVELOPMENT
UNIT X

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students information and job sheets.
- C. Make transparancies.
- D. Discuss unit objective.
- E. Discuss information sheets.
- F. Demonstrate and discuss procedures outlined in the job sheets.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheets.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheet.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
- C. Transparancy masters
    1. TM 1—Section of a Leaf
    2. TM 2—Photosynthesis
    3. TM 3—Basic Gas Composition

D. Job sheets

  1. Job Sheet #1—Production of Oxygen by Photosynthesis

  2. Job Sheet #2—Utilization of Oxygen in Respiration

E. Test

F. Answers to test

II. References:

A. Hartman, H. T., and Kester, D. E. *Plant Propagation: Principles and Practices:* Englewood Cliffs, New Jersey: Prentice Hall Inc., 1974.

B. *Garden Seed Product Information Manuel* Downers Grove, Illinois: Vaughn's Seed Company, 1974.

PLANT GROWTH AND DEVELOPMENT
UNIT X

INFORMATION SHEET

I. Terms and definitions

- A. Photosynthesis—Process by which plants form sugars from carbon dioxide and water through sunlight acting on chlorophyll
- B. CO_2—Chemical symbol for carbon dioxide
- C. H_2O—Chemical symbol for water
- D. O_2—Chemical symbol for oxygen
- E. Glucose—Name of a simple sugar

  (NOTE: The chemical symbol for glucose is $C_6H_{12}O_6$)
- F. Chloroplasts—Cells that contain chlorophyll (Transparency 1)
- G. Palisade mesophyll—Area of leaf where chloroplasts are located and where photosynthesis occurs
- H. Vascular bundle—Bundle of xylem and phloem cells that lend support and rigidity to leaves and stems
- I. Aeration—Exposure to air to obtain oxygen, carbon or both
- J. Nutrient—Material necessary for growth
- K. Transpiration—Giving off of water vapor through the stomates
- L. Respiration—Controlled breakdown of glucose to produce energy

II. Photosynthesis formula

$6CO_2$ (Carbon dioxide)$+12H_2O$ (water) $\xrightarrow[\text{sunlight}]{\text{chlorophyll}}$ $C_6H_{12}O$ (glucose)$+6O_2$ (oxygen) $+6H_2O$ (water).

III. Inputs of photosynthesis (Transparency 2)

- A. Water (H_2O)
- B. Carbon dioxide (CO_2)
- C. Sunlight

INFORMATION SHEET

IV. Products of photosynthesis

- A. Oxygen (O_2)
- B. Plant growth
- C. Glucose ($C_6H_{12}O_6$)—a simple sugar

V. Optimum temperature range for photosynthesis—Between 50°-75°F

VI. Chemical formula for respiration (Transparency 3)

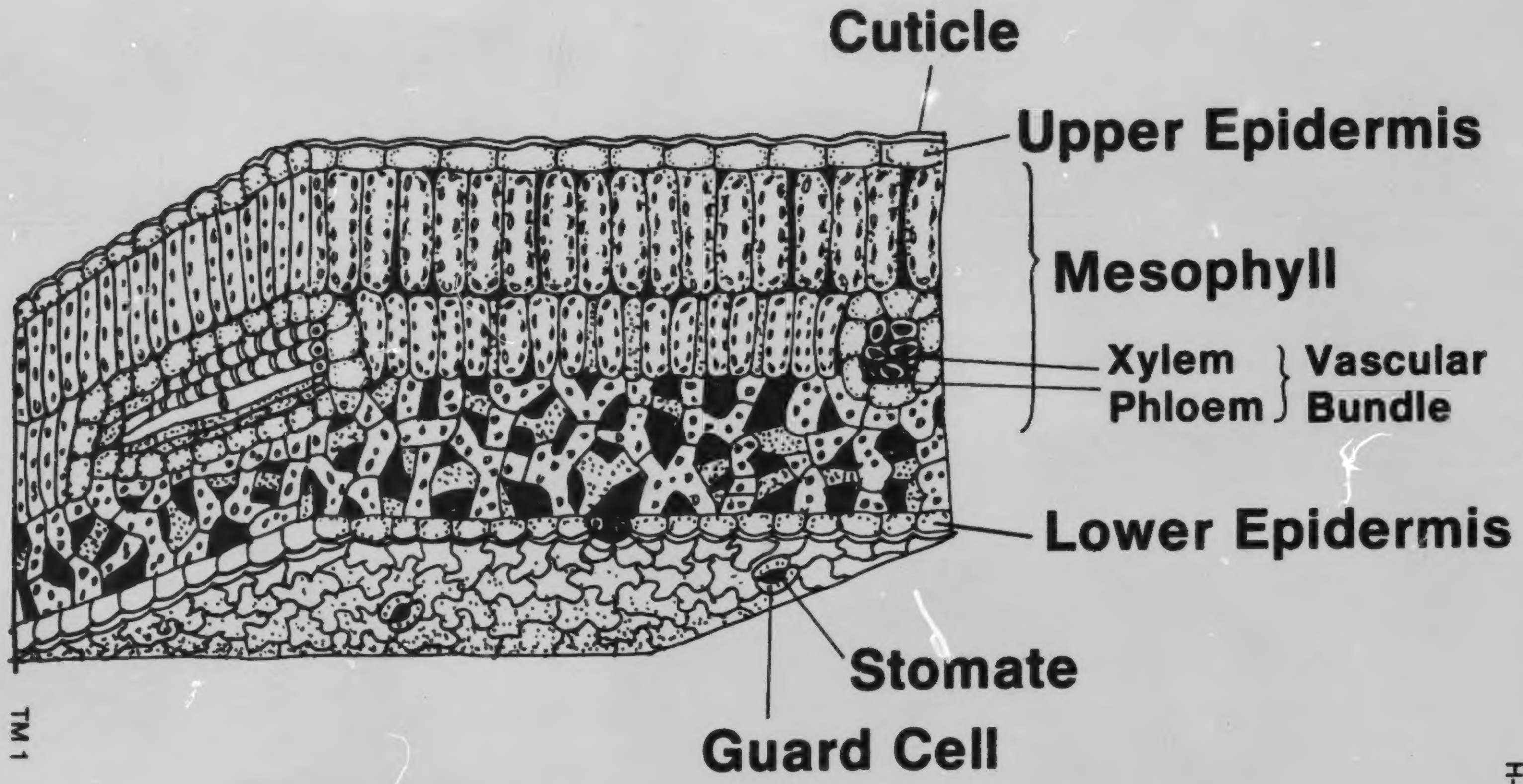
Glucose ($C_6H_{12}O_6$)+Oxygen (O_2)—Carbon Dioxide (CO_2)+Water (H_2O)+Energy

(NOTE: The formula for respiration is the reverse of the formula for photosynthesis.)

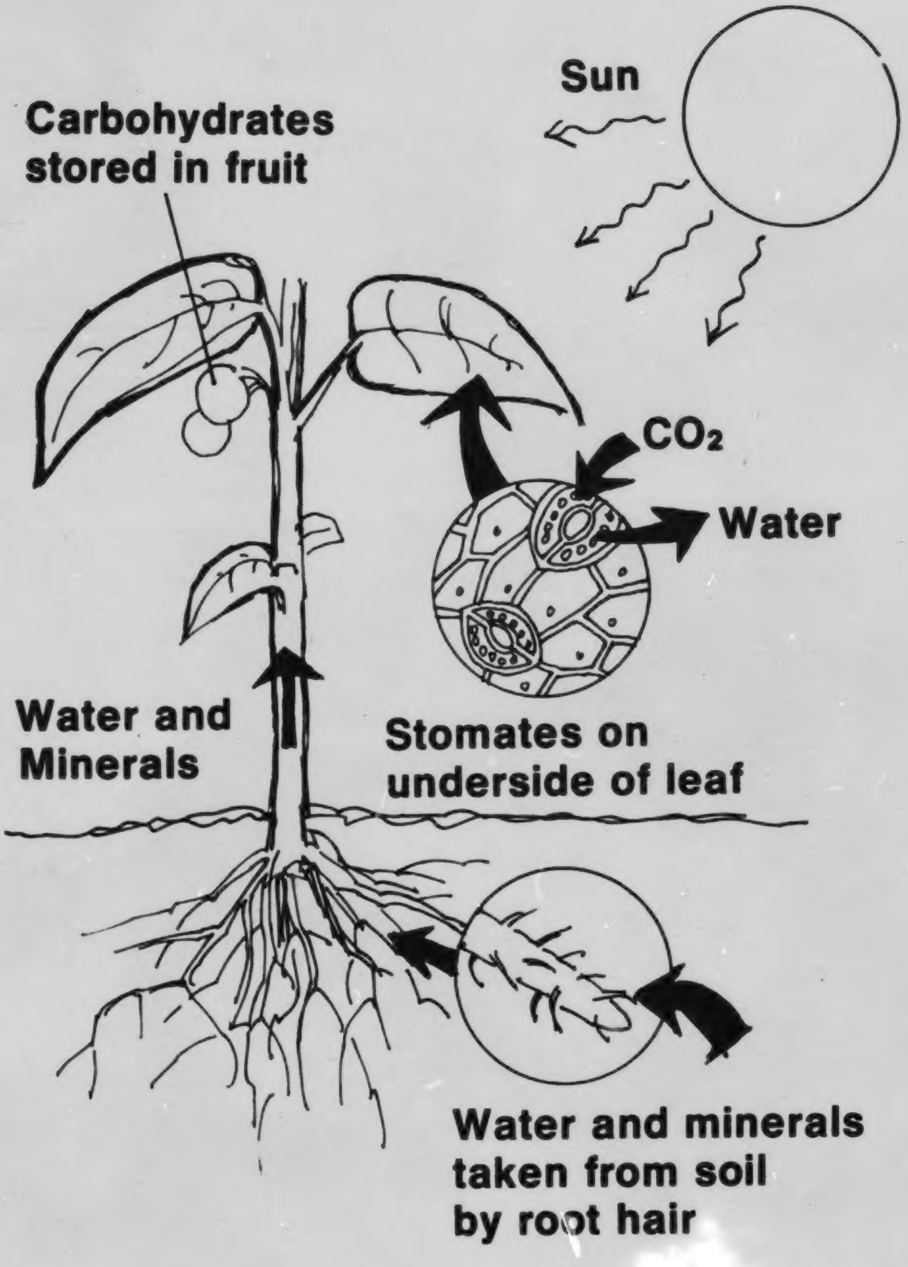
VII. Primary factors affecting respiration

- A. Temperature
- B. Available food supply
- C. Light

Leaf Parts

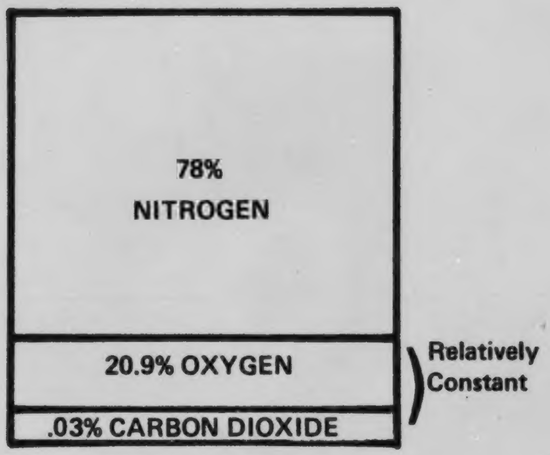

Cuticle
Upper Epidermis
Mesophyll
Xylem
Phloem
Vascular Bundle
Lower Epidermis
Stomate
Guard Cell

Photosynthesis

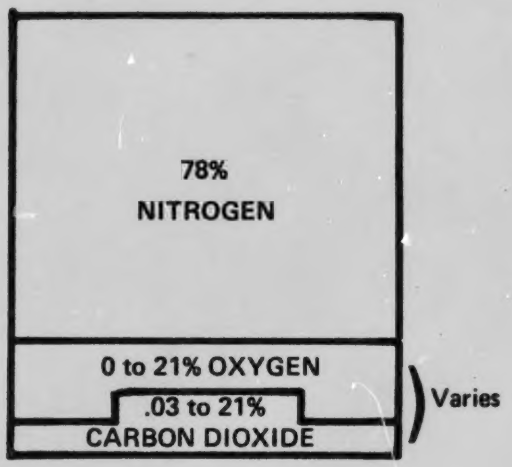

Sun
Carbohydrates stored in fruit
CO_2
Water
Water and Minerals
Stomates on underside of leaf
Water and minerals taken from soil by root hair

Basic Gas Composition

Air in Soil and Atmosphere


78%
NITROGEN
20.9% OXYGEN
.03% CARBON DIOXIDE
Relatively Constant

ATMOSPHERIC AIR


78%
NITROGEN
0 to 21% OXYGEN
.03 to 21%
CARBON DIOXIDE
Varies

SOIL AIR

PLANT GROWTH AND DEVELOPMENT
UNIT X

JOB SHEET #1—PRODUCTION OF OXYGEN BY PHOTOSYNTHESIS

I. Equipment:

- A. Elodea (aquatic plant available at aquarium stores)
- B. Large one gallon clear container
- C. Large spotlight, 500 watts
- D. One single edged razor blade

II. Procedure

- A. Fill the jar with clean, fresh water
- B. Place a piece of elodea in the water
- C. With a razor blade cut the elodea stem 2/3 of the way through
- D. Place the spotlight near the jar and turn it on
- E. Observe the cut edge of the elodea closely
- F. Turn off the spot light
- G. Observe the cut edge closely

PLANT GROWTH AND DEVELOPMENT
UNIT X

JOB SHEET #2—UTILIZATION OF OXYGEN IN RESPIRATION

(NOTE: The respiration formula shows that oxygen is used by all plants during respiration. This exercise should make this obvious.)

I. Equipment

   A. 10 bean or pea seeds (previously soaked in water for two days)

   B. Alkali solution (dissolve one tablespoon household lye in 1/4 cup of water)

      (CAUTION: This solution is dangerous! Wash off immediately if you should get some on your hands. A vinegar solution is best, but plenty of water in any case. WEAR SAFETY GLASSES!)

   C. One-2-oz. medicine bottle with a rubber stopper (with a hole in it)

   D. Three pipe cleaners

   E. Glass tube

   F. Millimeter ruler

II. Procedure

   A. Place the 10 germinating seeds loosely in the medicine bottle

   B. Fix the pipe cleaners on the stopper

   C. Dip end of pipe cleaner into the alkali solution

   D. Insert glass tube into rubber stopper and insert stopper into bottle

   E. Place a drop of colored water at end of glass tube

   F. Carefully lay ruler alongside glass tube so you can read distance on ruler as the bubble moves

      (NOTE: As soon as you place the drop of colored water at the end of the glass tube, this begins "O" time.)

   G. Measure the distance the bubble moves at the end of 10, 20, 30, 40, 50 and 60 minutes

PLANT GROWTH AND DEVELOPMENT
UNIT X

TEST

1. Match the terms on the right with the correct definitions.

___ a. Giving off of water vapor through the stomates

___ b. Exposure to air to obtain oxygen, carbon, or both

___ c. Chemical symbol for carbon dioxide

___ d. Chemical symbol for oxygen

___ e. Chemical symbol for water

___ f. Name of a simple sugar

___ g. Process by which plants form sugars from carbon dioxide and water through sunlight acting on chlorophyll

___ h. Area of leaf where chloroplasts are located and where photosynthesis occurs

___ i. Bundle of xylem and phloem cells that lend support and rigidity to leaves and stems

___ j. Controlled breakdown of glucose to produce energy

___ k. Material necessary for growth

___ l. Cells that contain clorophyll

1. CO_2
2. H_2O
3. O_2
4. Glucose
5. Chloroplasts
6. Palisade mesophyll
7. Vascular bundle
8. Transpiration
9. Aeration
10. Respiration
11. Nutrient
12. Photosynthesis

2. State the photosynthesis formula using chemical symbols.

3. List three inputs of photosynthesis.

   a.

   b.

   c.

4. List three products of photosynthesis.

   a.

   b.

   c.

5. State the optimum temperature range for photosynthesis.

6. State the chemical formula for respiration using chemical symbols.

7. Name three primary factors affecting respiration.

   a.

   b.

   c.

8. Demonstrate oxygen production by photosynthesis in elodea.

9. Demonstrate the respiration process.

   (NOTE: If activities 8 and 9 have not been accomplished prior to the test, ask your instructor when they should be completed.)

PLANT GROWTH AND DEVELOPMENT
UNIT X

ANSWERS TO TEST

1. a. 8
   b. 4
   c. 1
   d. 3
   e. 2
   f. 4
   g. 12
   h. 6
   i. 7
   j. 10
   k. 11
   l. 5

2. $6CO_2 + 12H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$

3. a. Water

   b. Carbon dioxide

   c. Sunlight

4. a. Oxygen

   b. Plant growth

   c. Glucose

5. Between 50°-75°F

6. $C_6H_{12}O6 + O_2 \text{—} CO_2 + H_2O + \text{Energy}$

7. a. Temperature

   b. Available food supply

   c. Light

8. Performance skill evaluated to the satisfaction of the instructor.

9. Performance skill evaluated to the satisfaction of the instructor.

SEEDS
UNIT XI

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the main parts of a seed and state their functions. The student should also be able to germinate seeds in different growing environments and determine the effects of these environments on growth. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with seeds to the correct definitions.
2. Identify the three main parts of a seed.
3. List the five requirements for good seed germination.
4. List three factors that cause poor seed germination.
5. Match the three main parts of a seed to the correct functions.
6. Demonstrate the ability to:
    a. Identify the principle parts of the seed.
    b. Germinate seeds in different growing environments.

SEEDS
UNIT XI

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheets.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Give test.

II. Students:

   A. Read objectives.

   B. Study information sheets.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheets

   C. Transparency masters

      1. TM 1—Views of Corn and Bean Seeds

      2. TM 2—Factors Affecting Seed Germination

      3. TM 3—Factors Influencing Germination

D. Job sheets

   1. Job Sheet #1—Identifying Principle Parts of the Seed

   2. Job Sheet #2—Seed Germination in Different Growing Environments

E. Test

F. Answers to test

II. References:

A. Hartman, H. T., and Kester, D. E., *Plant Propagation: Principles and Practices.* Englewood Cliffs: Prentice-Hall, Inc., 1974.

B. *Garden Seed Product Information Manual.* Downers Grove, Illinois: Vaughn's Seed Company, 1974.

SEEDS
UNIT XI

INFORMATION SHEET

I. Terms and definitions

  A. Seed propagation—Increase in the plant population by seeds

  B. Liability—Ability of a seed to be able to germinate or come to life

  C. Propagation—Controlled reproduction of plants

  D. Variety—Group of closely related plants of common origin which have similar characteristics

  E. Seed—Ripened ovule

  F. Cotyledons—Seed leaves of the embryo; also the food storage area for dicotyledonous seeds

  G. Dicotyledonous plants—Plant with two seed leaves in the seed

  H. Embryo—Small, dormant plant inside the seed coat

  I. Endosperm—Special food storage area for monocotyledonous seeds

  J. Monocotyledonous plants—Plants with one seed leaf in the seed

  K. Plumule—Growth bud located at the apex where new growth begins

  L. Seed coat—Covering which encloses the internal parts of a seed

  M. Dormant condition—Time during which no growth occurs because of unfavorable environment

  N. Seed germination—Process in which the embryo resumes growth

  O. Damping-off—Disease which attacks seedlings at the soil line and kills them; occurs under wet, humid conditions when the disease is present

II. Main Parts of a Seed (Transparency 1)

  A. *Seed Coat*

  B. *Embryo*—an embryo has three parts:

    1. *Cotyledons*
    2. *Plumule*
    3. *Root tip*

  C. *Endosperm*

INFORMATION SHEET

III. Requirements for good seed germination (Transparency 2)

   A. Seed

   B. Germination media

   C. Moisture

   D. Temperature

   E. Oxygen

IV. Factors causing poor seed germination (Transparency 3)

   A. Damaged seed

   B. Old seed

   C. Soil or media too wet

   D. Temperature too cold

   E. Hard seed

   F. Chemical damage

   G. Disease

   H. Drying out of media

   I. Planting too deep

   J. Dormancy or rest period

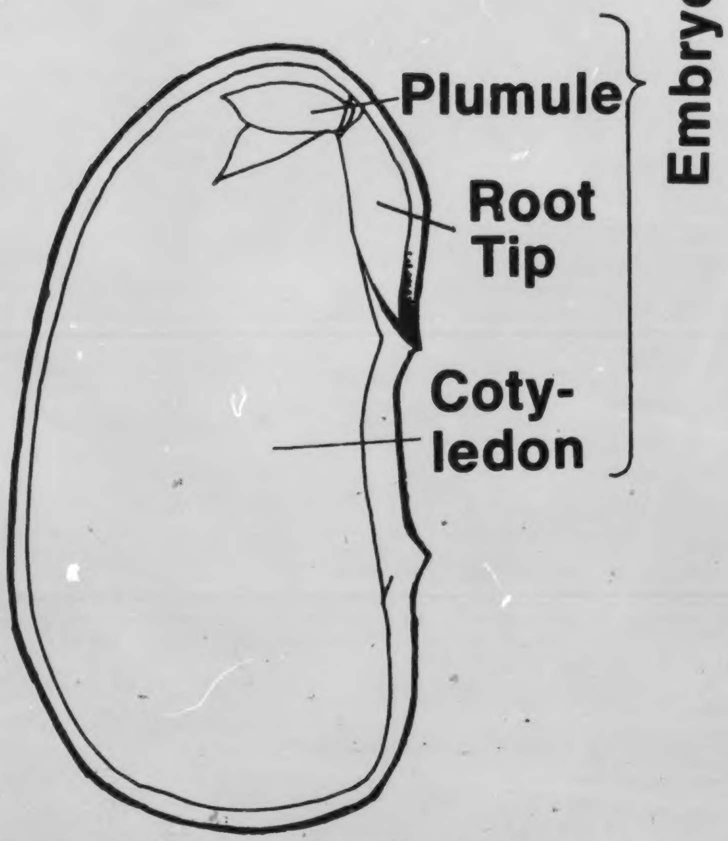
V. Functions of the main parts of a seed

   A. Seed coat
      1. Keeps from drying out
      2. Contains food supply for new plant
      3. Protects embryo from mechanical injury

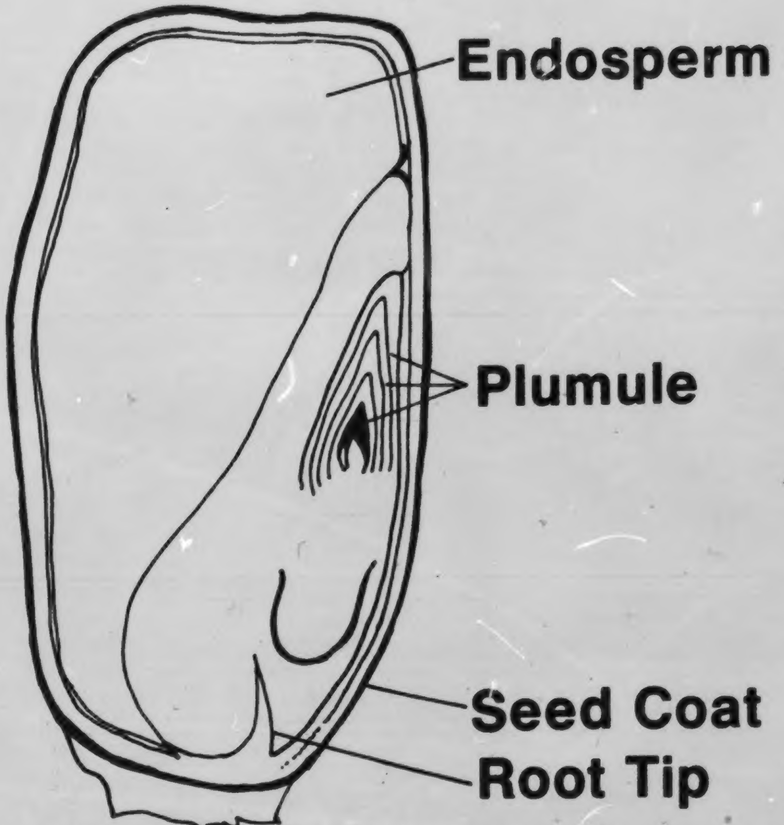
   B. Embryo
      1. Dicotyledon
         a. Stores food
         b. Protects plumule
      2. Monocotyledon—protects plumule

   C. Root tip
      1. Anchors plant
      2. Absorbs water and nutrients

Views of Corn and Bean Seeds


Plumule
Root Tip
Coty-ledon
Embryo

TM 1 **BEAN SEED (Dicot)**


Endosperm
Plumule
Seed Coat
Root Tip

CORN SEED (Monocot)

H-255-A

FACTORS AFFECTING SEED GERMINATION

SEED

GERMINATION MEDIA

MOISTURE

TEMPERATURE

OXYGEN

TM 2

FACTORS INFLUENCING GERMINATION

DAMAGED SEED

OLD SEED

SOIL OR MEDIA TOO WET

TEMPERATURE TOO COLD

HARD SEED

CHEMICAL DAMAGE

DISEASE

DRYING OUT OF MEDIA

PLANTING TOO DEEP

DORMANCY OR REST PERIOD

SEEDS
UNIT XI

JOB SHEET #1—IDENTIFYING PRINCIPAL PARTS OF THE SEED

I. MATERIALS

   A. Bean seed

   B. Sharp knife

   C. Magnifying lens

II. PROCEDURE

   A. Remove the seed coat

   B. Carefully split the bean down the middle to expose the embryo and cotyledons

   C. Make a drawing of each half of the bean

   D. Label each part: seed coat, root tip, cotyledons, and plumule

   E. On your drawing identify the embryo

SEEDS
UNIT XI

JOB SHEET #2—SEED GERMINATION IN DIFFERENT GROWING ENVIRONMENTS

I. Materials

A. Large seeds (sweet corn, pumpkins, beans)

B. Five large-mouth glass jars

C. Peat moss, vermiculite, wood shavings, or sawdust

D. Paper towels

II. Procedures

A. Line five large-mouth jars with paper towels

B. Fill the jars with peat moss, vermiculite, wood shavings, or sawdust

C. Place some of the large seeds between the paper and the glass

D. Moisten the filling in three jars and add about one inch of water to the jars

E. Label one of these jars and place in a warm place

F. Label one jar and place in a refrigerator to show the effect of lower temperature

G. Label and tightly seal one jar and place in in a warm place to show the effect of lack of air

(NOTE: Perhaps it would be good to use a jar which had been inverted over a burning candle to exhaust the atmospheric air supply first)

H. Fill one jar completely full of water to show the effect of too much water; label and place in a warm place

I. Label and do not add any water to the fifth jar to show the effect of no water; place in a warm place

J. After about ten days, observe what has happened to the seeds in each jar and record your findings

SEEDS
UNIT XI

TEST

1. Match the terms on the right to the correct definitions.

____ a. Increase in the plant population by seeds

____ b. Time during which no growth occurs because of unfavorable environment

____ c. Seed leaves of the embryo; also the food storage area for dicotyledonous seeds

____ d. Growth bud located at the apex where new growth begins

____ e. Disease which attacks seedlings at the soil line and kills them; occurs under wet humid conditions when the disease is present

____ f. Plants with one seed leaf in the seed

____ g. Ability of a seed to be able to germinate or come to life

____ h. Process in which the embryo resumes growth

____ i. Small, dormant plant inside the seed coat

____ j. Ripened ovule

____ k. Controlled reproduction of plants

____ l. Covering which encloses the internal parts of a seed

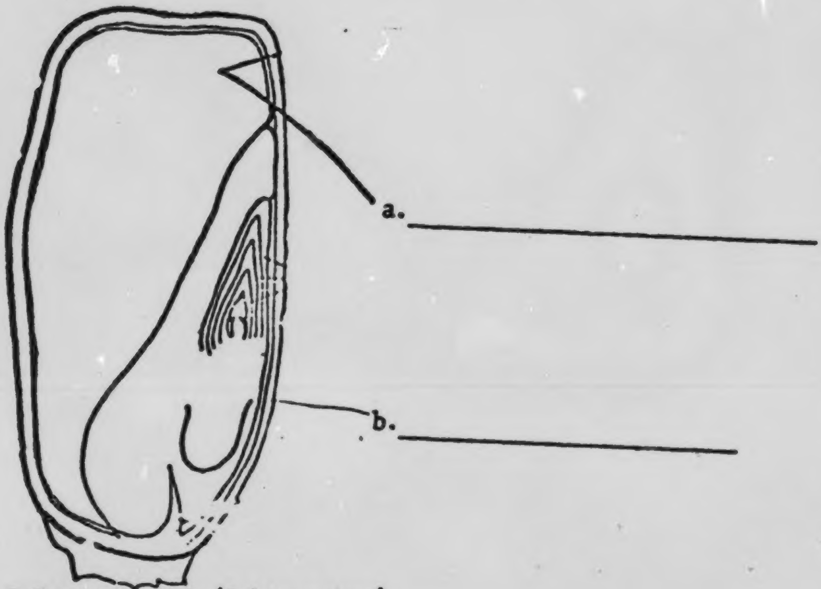
____ m. Group of closely related plants of common origin which have similar characteristics

____ n. Special food storage area for monocotyledonous seeds

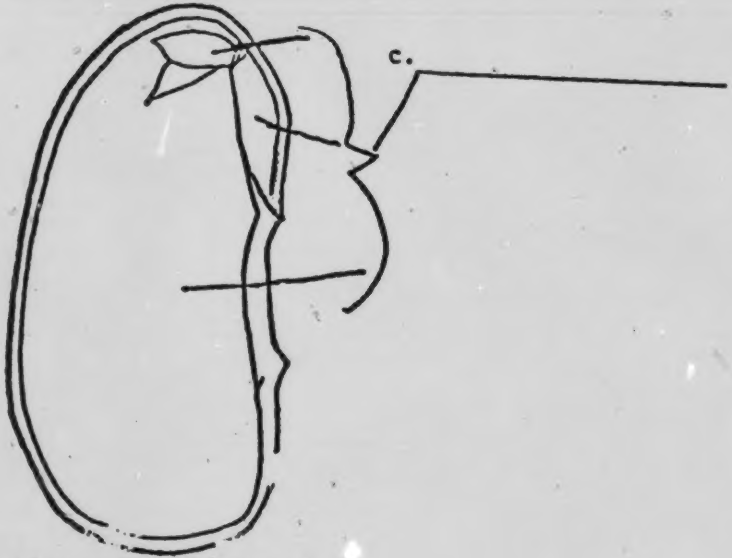
____ o. Plant with two seed leaves in the seed

1. Seed coat
2. Plumule
3. Dormant condition
4. Monocotyledonous
5. Seed germination
6. Endosperm
7. Damping off
8. Embryo
9. Cotyledons
10. Seed
11. Variety
12. Propagation
13. Seed propagation
14. Dicotyledonous
15. Liability

2. Identify the three main parts of a seed.



CORN SEED (Monocot)



BEAN SEED (Dicot)

3. List the five requirements for good seed germination.

   a.

   b.

   c.

   d.

   e.

4. List three factors that cause poor seed germination.

   a.

   b.

   c.

5. Match the three main parts of the seed on the right to their correct functions. A blank may have more than one correct answer.

   ____ a. Anchors plant

   ____ b. Keeps seed from drying out

   ____ c. Protects embryo from mechanical injury

   ____ d. Protects plumule

   ____ e. Absorbs water and nutrients

   ____ f. Contains food supply for new plant

   ____ g. Stores food

   1. Seed coat
   2. Dicotyledons
   3. Monocotyledonous
   4. Root tip

6. Demonstrate the ability to:

   a. Identify the principle parts of the seed.

   b. Germinate seeds in different growing environments.

SEEDS
UNIT XI

ANSWERS TO TEST

1. a. 13
   b. 3
   c. 9
   d. 2
   e. 7
   f. 4
   g. 15
   h. 5
   i. 8
   j. 10
   k. 12
   l. 1
   m. 11
   n. 6
   o. 14

2. a. Endosperm

   b. Seed coat

   c. Embryo

3. a. Seed

   b. Germination media

   c. Moisture

   d. Temperature

   e. Oxygen

4. Any three of the following:

   a) Damaged seed

   b) Old seed

   c) Soil or media too wet

   d) Temperature too cold

   e) Hard seed

f) Chemical damage

g) Disease

h) Drying out of media

i) Planting too deep

j) Dormancy or rest period

5. a. 4
   b. 1
   c. 1
   d. 2,3
   e. 4
   f. 1
   g. 2

6. Performance skills evaluated to satisfaction of instructor.

TURF GRASS PRODUCTION
UNIT XII

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify major parts of grasses and match the grasses to the functions of each. The student should be able to describe characteristics of turf grasses and asexual and sexual propagation. The student should be able to prepare a lawn seedbed, spot seed an established lawn, seed a new lawn, and mow grass properly. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with turf grass production with the correct definitions.
2. Identify the parts of a grass plant.
3. Match the names of five major parts of grasses with appropriate description of each part.
4. Describe seven turf grass plants.
5. Describe two methods of asexual turf propagation.
6. Describe two methods of sexual turf propagation.
7. Demonstrate the ability to:
    a. Prepare a seedbed.
    b. Spot seed an established lawn.
    c. Seed a new lawn.
    d. Mow grass properly.

TURF GRASS PRODUCTION
UNIT XII

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Arrange field trip to allow identification of turf grasses.

   H. Give test.

II. Student:

   A. Read objectives.

   B. Study information sheets.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Participate in field trip.

   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheets

   C. Transparency masters

      1. TM 1—Principle Parts of a Grass Plant

      2. TM 2—Ryegrass

   3. TM 3—Bluegrass
   4. TM 4—Bentgrass
   5. TM 5—Fine Fescue Grass
   6. TM 6—Tall Fescue Grass
   7. TM 7—Bermuda Grass
   8. TM 8—Zoysiagrass

D. Assignment sheet #1—Collect and Identify Turf Grass Plants

E. Job sheets

   1. Job Sheet #1—Propare a Seedbed
   2. Job Sheet #2—Spot Seed an Established Lawn
   3. Job Sheet #3—Seed a New Lawn
   4. Job Sheet #4—Mow Grass Properly

F. Test

G. Answers to test

II. References:

A. Hartman, H. T., and Kester, D. E. *Plant Propagation: Principles and Practices.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1974.

B. *Professional Turf Seminar.* O. M. Scott and Sons Co., 1971.

TURF GRASS PRODUCTION
UNIT XII

INFORMATION SHEET

I. Terms and definitions

A. Cool season grasses—Grasses which grow during the fall, winter, or spring

B. Warm season grasses—Grasses which grow during the summer and early fall

C. Sod—Thick, short plant growth along with the soil that is filled with roots, grass, herbs

Examples: Turf, lawn

D. Annual—Plant which completes its life cycle within one year and then dies

E. Perennial—Plant which lives three or more years

F. Rhizome—Stem that grows under the soil surface like a root; has well developed nodes and internodes

G. Stolon—Modified stem that grows horizontally above the soil surface, taking root when it branches out from the parent plant and touches the ground

H. Hybrid—Offspring of two parents which differ in one or more heritable characters

I. Dormant—Not in an active state of growth

J. Sprig—Vegetative plant that is prepared for planting by chopping or shredding so that it can be planted uniformly

Examples: Bermudagrass bentgrass

K. Plug—"Spot sod;" essentially the setting of 3" or 4" cubes of cut sod into a prepared seedbed at spaced intervals

II. Parts of a grass plant (Transparency 1)

A. Inflorescence (seedhead)

B. Blade

C. Ligule

D. Sheath

E. Auricle

INFORMATION SHEET

F. Collar

G. Node

H. Stolon

I. Crown

J. Rhizome (Underground stem)

III. Major parts of grasses

A. Blade

1. Rolled or folded in bud
2. Separated from plant by collar and ligule
3. Varies in size, shape, and type of tip
4. Smooth or hairy

B. Sheath

1. Lower leaf around the stem
2. May be rough, smooth, or hairy
3. Cylindrical shape

C. Ligule

1. Joins stem at junction of blade and sheath
2. Tall, short-toothed shape
3. Membranous or hairy type

D. Auricle—Projects from either side of the collar

E. Collar

1. Outerside of leaf junction of blade and sheath
2. Lighter color
3. Broad or narrow shape
4. Continuous or divided by midrib

INFORMATION SHEET

IV. Turf grasses

A. Cool season grasses

1. Ryegrass (Transparency 2)

a. Adaptation

1. High germination
2. Establish rapidly
3. Nurse crop, annual ryegrass
4. Conserves moisture (annual ryegrass)
5. Winter kills easily (perennial ryegrass)

b. Characteristics

1. Medium to coarse texture
2. Light to dark green color
3. Upper surface is veined, below is glossy
4. Spreads by tillers

c. Maintenance—Mow at 1½ to 2½ inches

2. Bluegrass (Transparency 3)

a. Adaptation

1. Temperate cool regions
2. Kentucky Bluegrass most popular
3. Most diversified grass

b. Characteristics

1. Dark blue-green color
2. Fine texture
3. Spreads by tillers and rhizomes
4. Grows on heavy, well-drained soil

INFORMATION SHEET

c. Maintenance
    1. Mow at 2 to 3 inches
    2. Cutting shorter than 2 inches will weaken turf

3. Bentgrass (Transparency 4)
    a. Adaptation
        1. Cut extremely low
        2. Use only on golf course greens
    b. Characteristics
        1. Light to dark green color
        2. Fine texture
        3. Spread by stolons
        4. Matting growth
        5. Mix with other desirable grasses
    c. Maintenance—Mow at ¼ and 1 inch, one to two times a week

4. Fine fescue (Transparency 5)
    a. Adaptation
        1. Designed for shady areas
        2. Germinates quickly
        3. Establishes quickly
        4. Protects slower growing plants
    b. Characteristics
        1. Medium green in color
        2. Spreads by tillers and rhizomes
        3. Seldom grows in pure stands
        4. Competes poorly with aggressive turf grasses
    c. Maintenance—Mow regularly at 1½ to 2½ inches

INFORMATION SHEET

5. Tall fescue (Transparency 6)
   a. Adaptation
      1. Low maintanence turf
      2. Course turf
      3. Grows in sun or shade
      4. Withstands abuse of heavy traffic
   b. Characteristics
      1. Medium to dark green color
      2. Limited tiller growth
      3. Open turf
      4. Deep root growth
      5. Performs in periods of heavy moisture and extended drought
      6. Grows in clumps
   c. Maintenance
      1. Mow at height of 2 to 3 inches
      2. Use sharp mower blade

B. Warm season grasses
   1. Bermudagrass (Transparency 7)
      a. Adaptation
         1. Very adaptive
         2. Easy to maintain
         3. Dense turf
         4. Coarse stemming unless top dressed and brushed
      b. Characteristics
         1. Medium dark green
         2. Spreads by stolons and rhizomes

INFORMATION SHEET

3. Aggressive, rapid recover from damage
4. Cooler regions turns brown and into dormancy
5. Grows well in sunny, well-drained neutral soil

c. Maintenance

1. Improved turf mow at ¼ to 1 inch
2. Common turf mow at 1 to 2 inches
3. Mow 2 to 3 times per week

2. Zoysiagrass

   a. Adaptation

      1. Southern areas only
      2. Northern areas turns brown with first frost
      3. Last grass to turn green in spring
      4. Slow development

   b. Characteristics

      1. Fine medium texture
      2. Dark green color
      3. Spreads by stolon and short rhizomes
      4. Planted vegetatively
      5. Requires adequate watering

   c. Maintenance

      1. Mow ½ to 1 inch
      2. Fertilize frequently

V. Asexual turf production

   A. Vegetative planting—Limited to grasses producing an abundance of creep stem

   B. Spot sodding

      1. Setting cubes of cut sod in seedbed
      2. Sod 12 to 16 inches wide, 24 to 36 inches long, and ¾ to 1 inch thick

VI. Sexual turf production

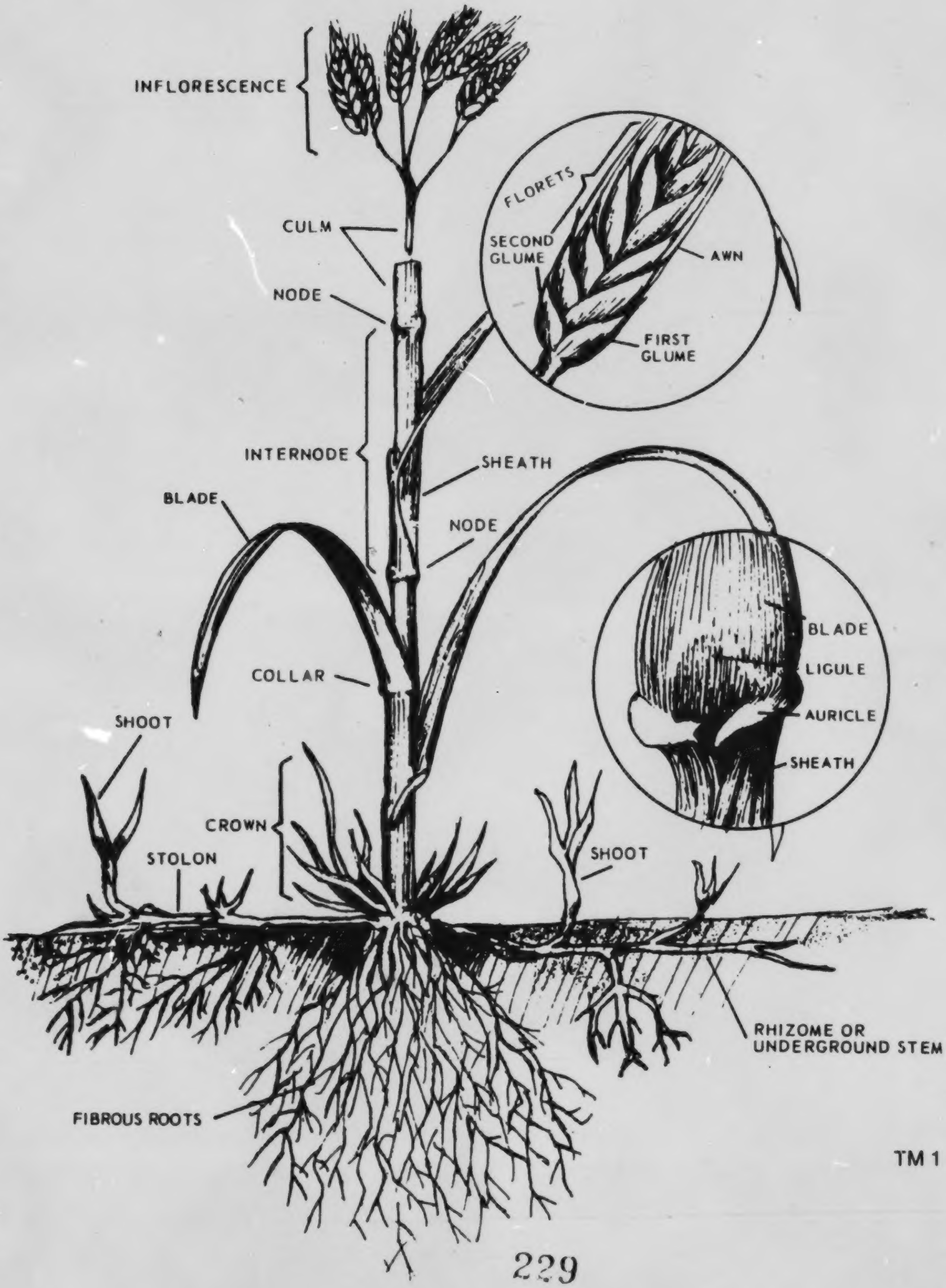
   A. Seed

      1. Most common
      2. Broadcast on seedbed

   B. Dormant seeding

      1. Seed applied in fall
      2. Seed dormant through winter; germinates in spring
      3. Early turf establishment

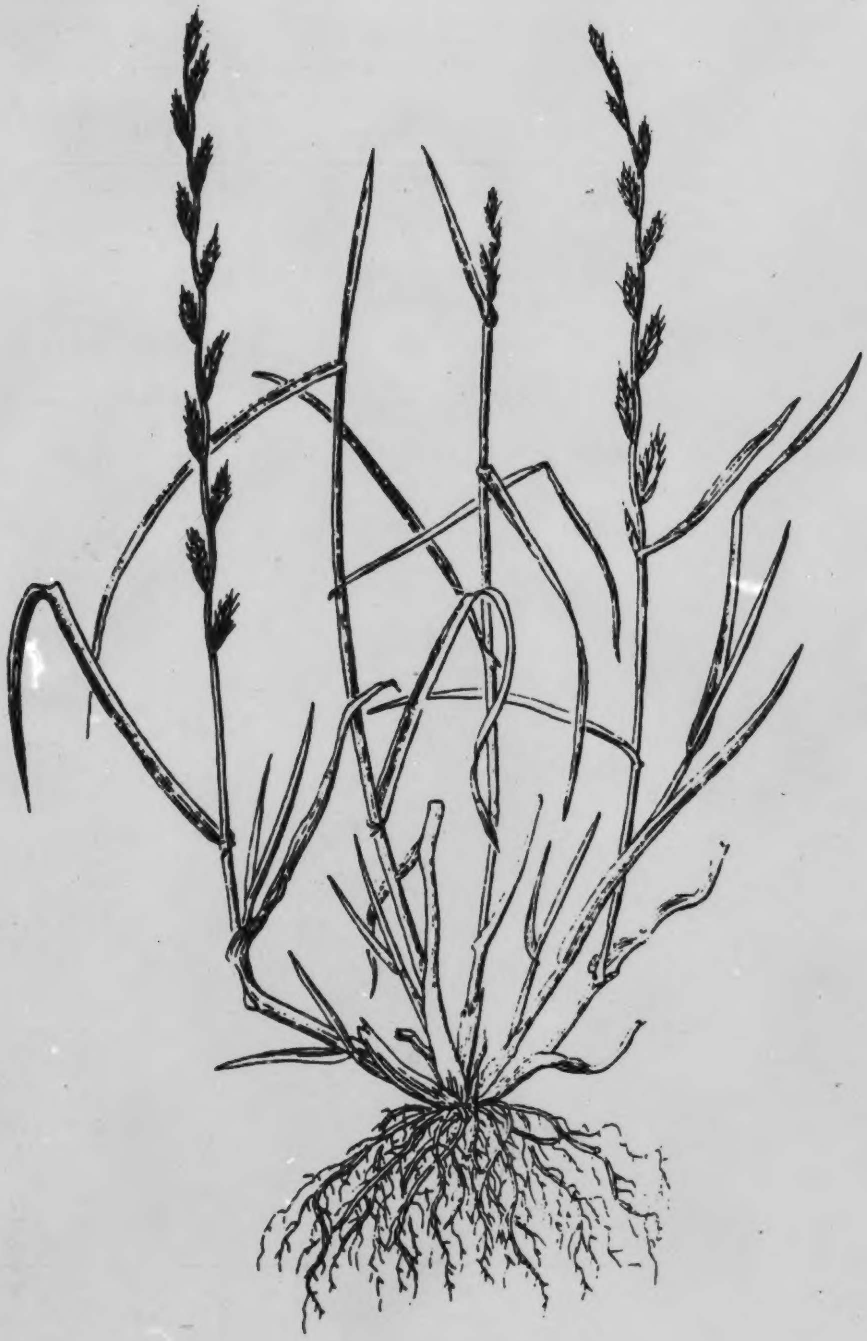
Principle Parts of a Grass Plant

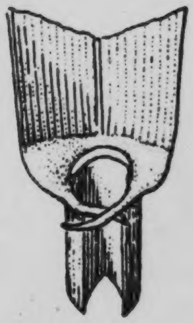

INFLORESCENCE
FLORETS
SECOND GLUME
AWN
FIRST GLUME
CULM
NODE
INTERNODE
SHEATH
BLADE
NODE
BLADE
LIGULE
AURICLE
SHEATH
COLLAR
SHOOT
CROWN
STOLON
SHOOT
RHIZOME OR UNDERGROUND STEM
FIBROUS ROOTS

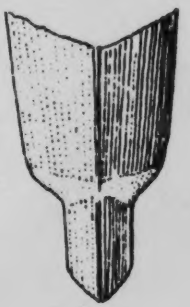
TM 1

H-283-A

RYEGRASS



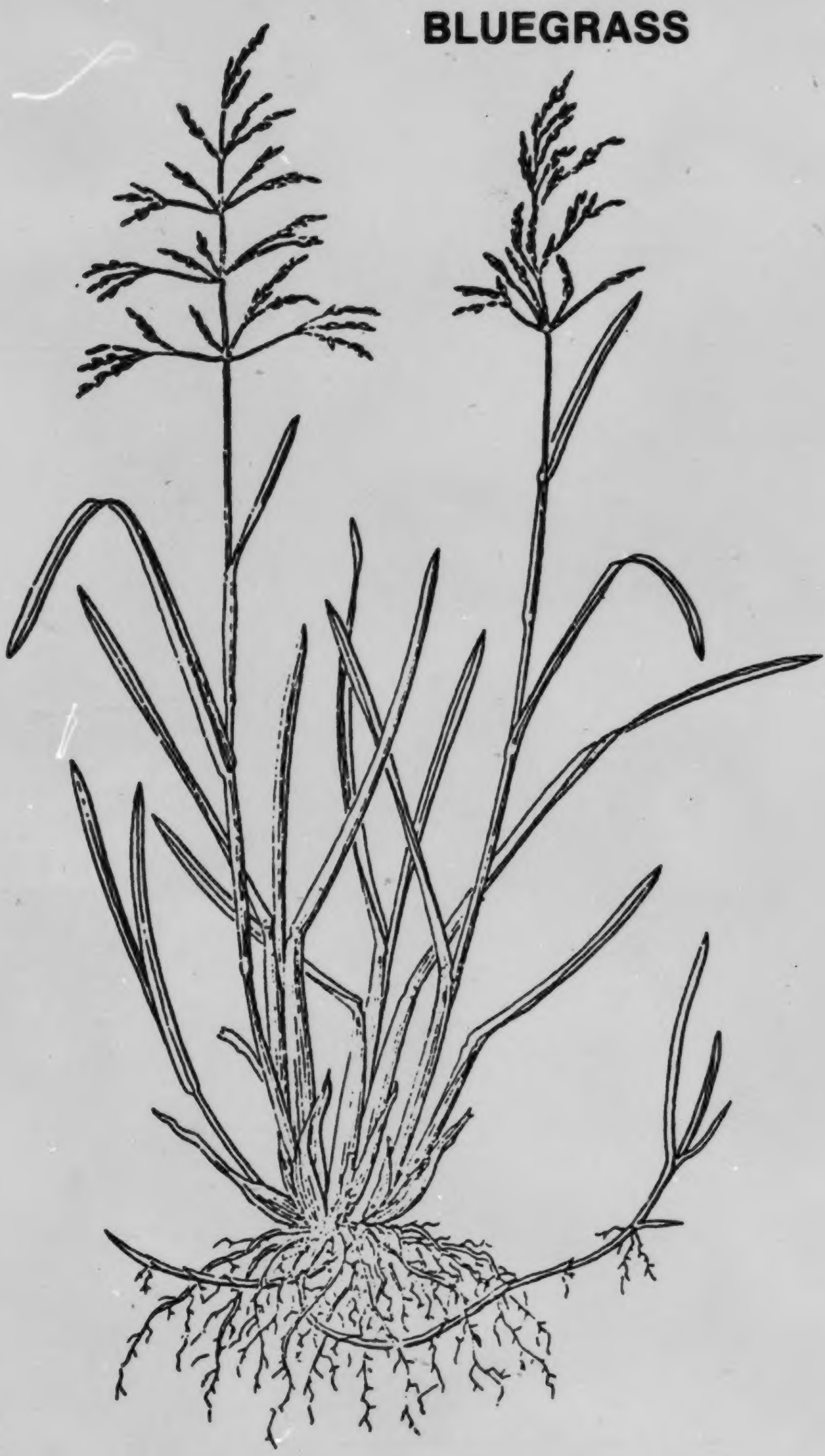


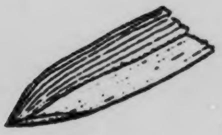


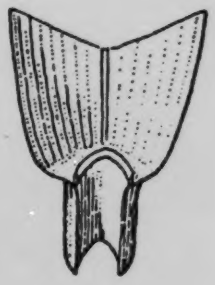
TM 2

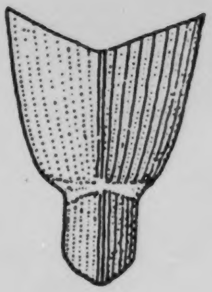
BLUEGRASS

H-285-A



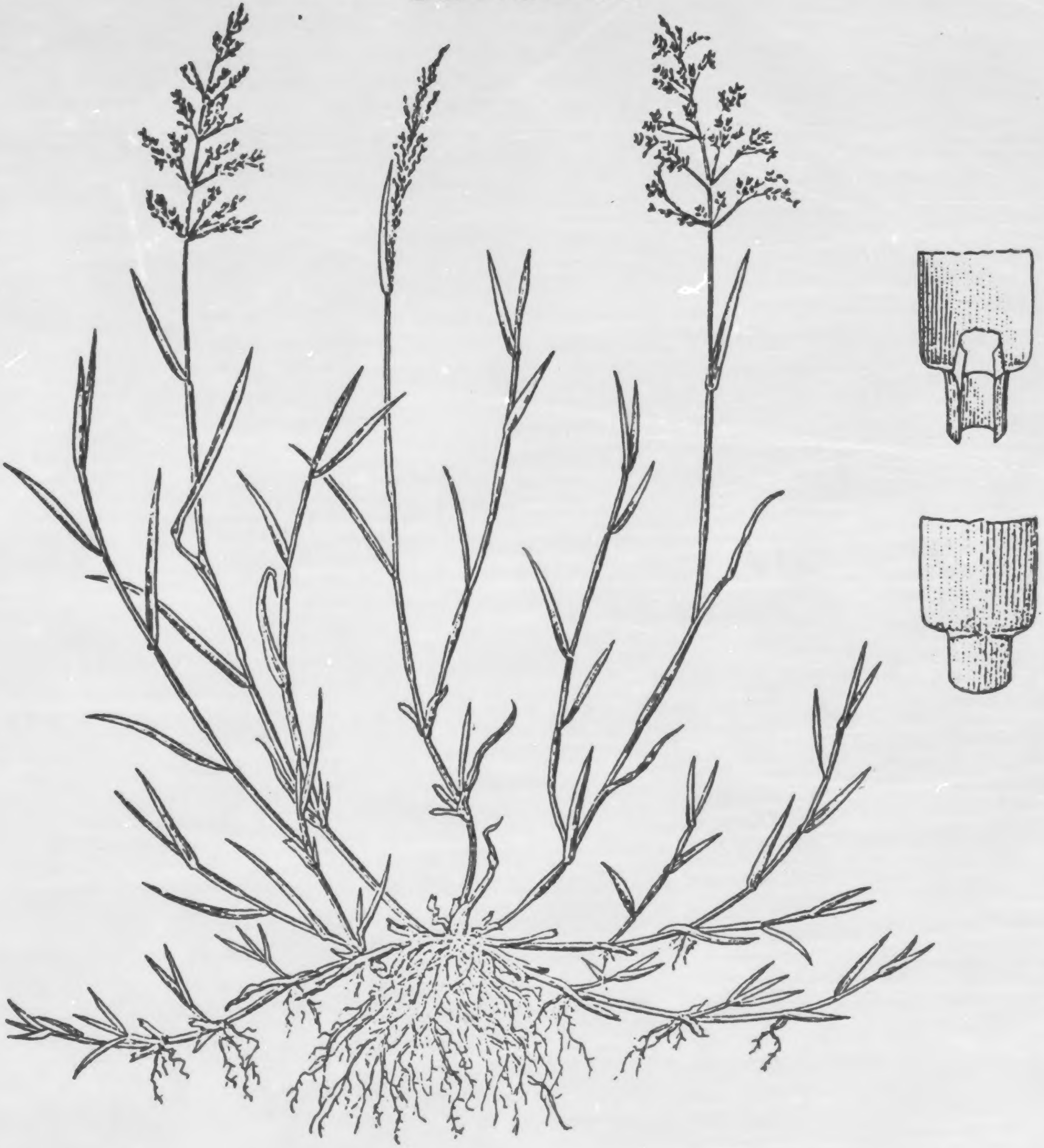






TM 3

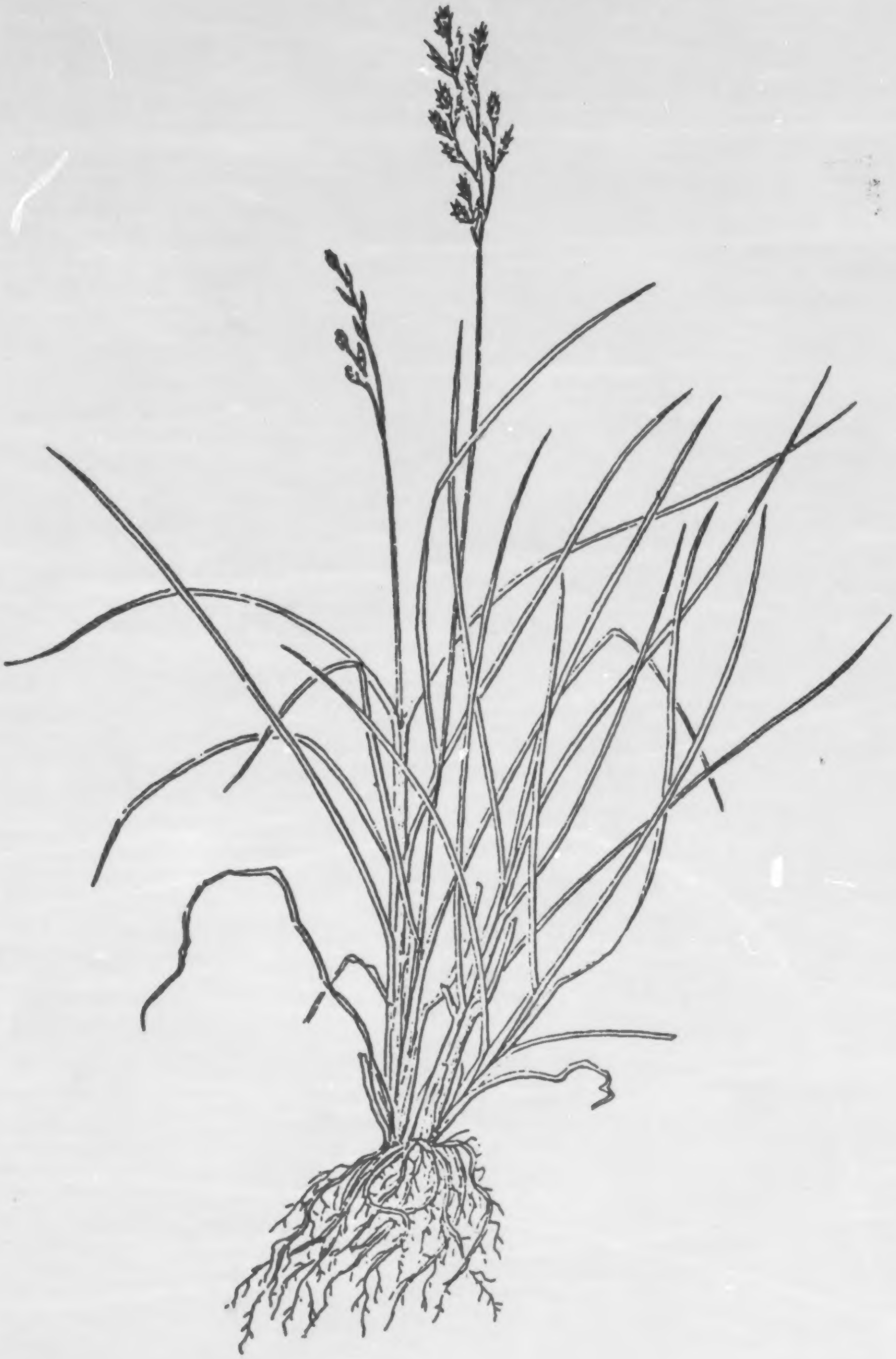
BENTGRASS

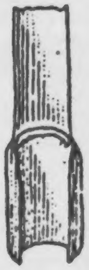


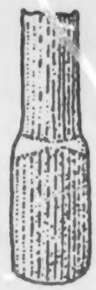
TM 4

FINE FESCUE GRASS

H-289-A







TM 5

TALL FESCUE GRASS

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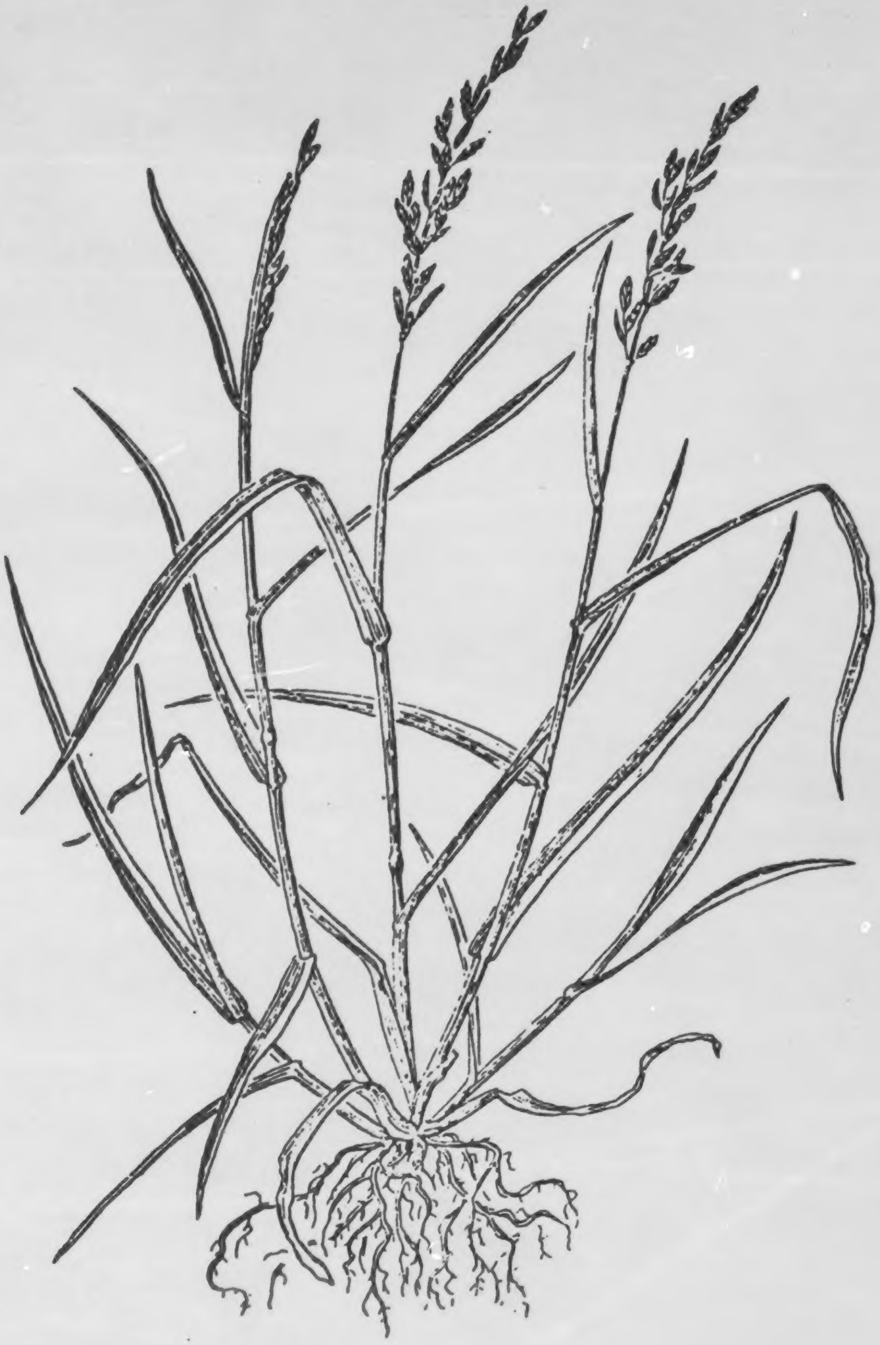
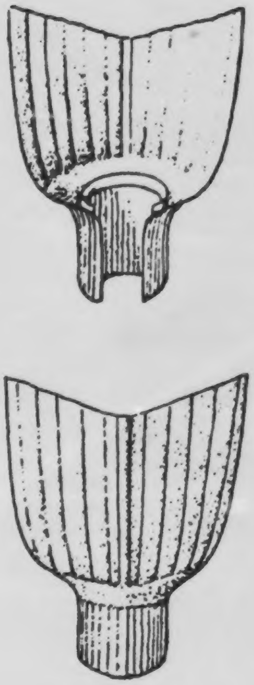
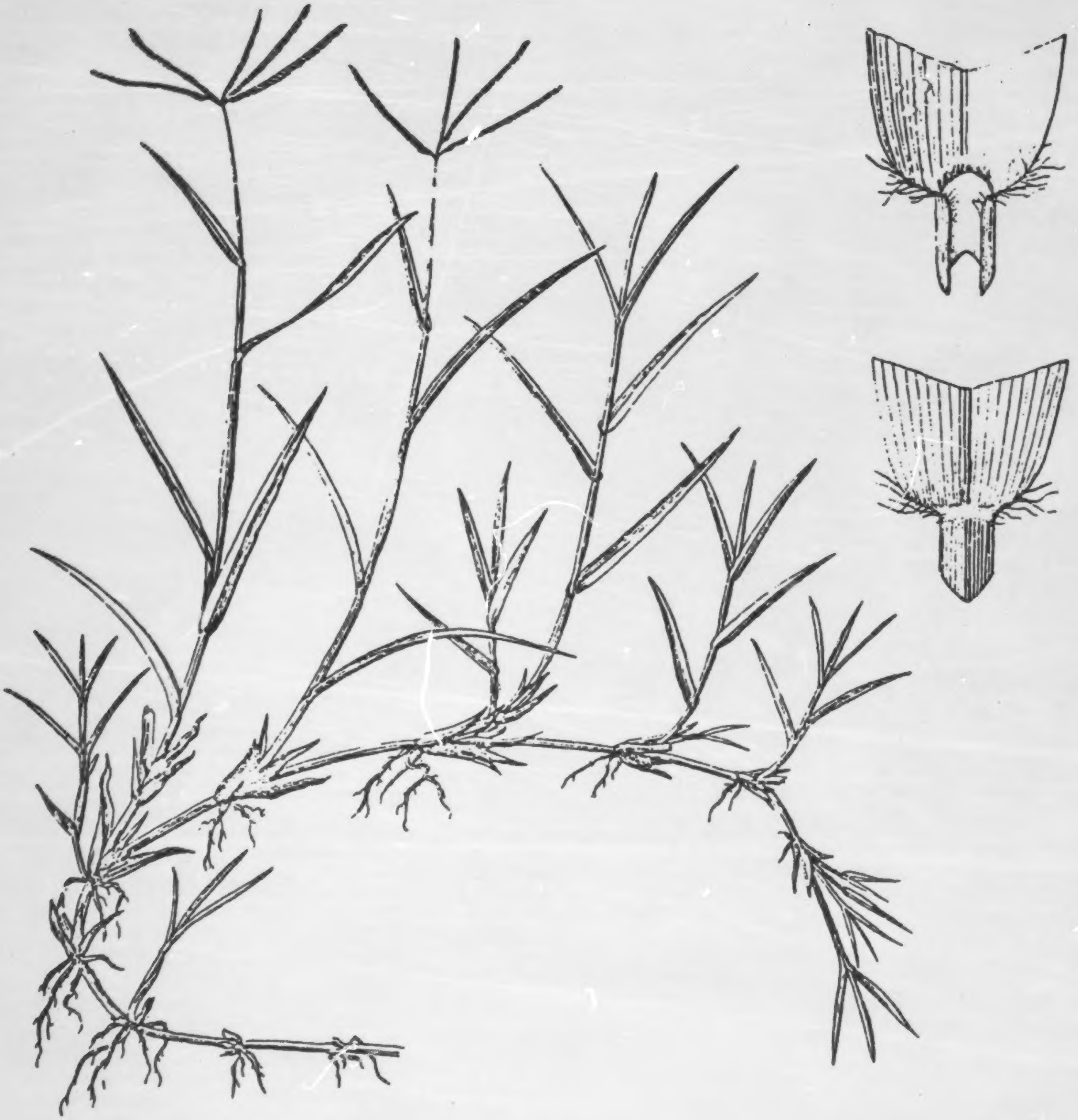




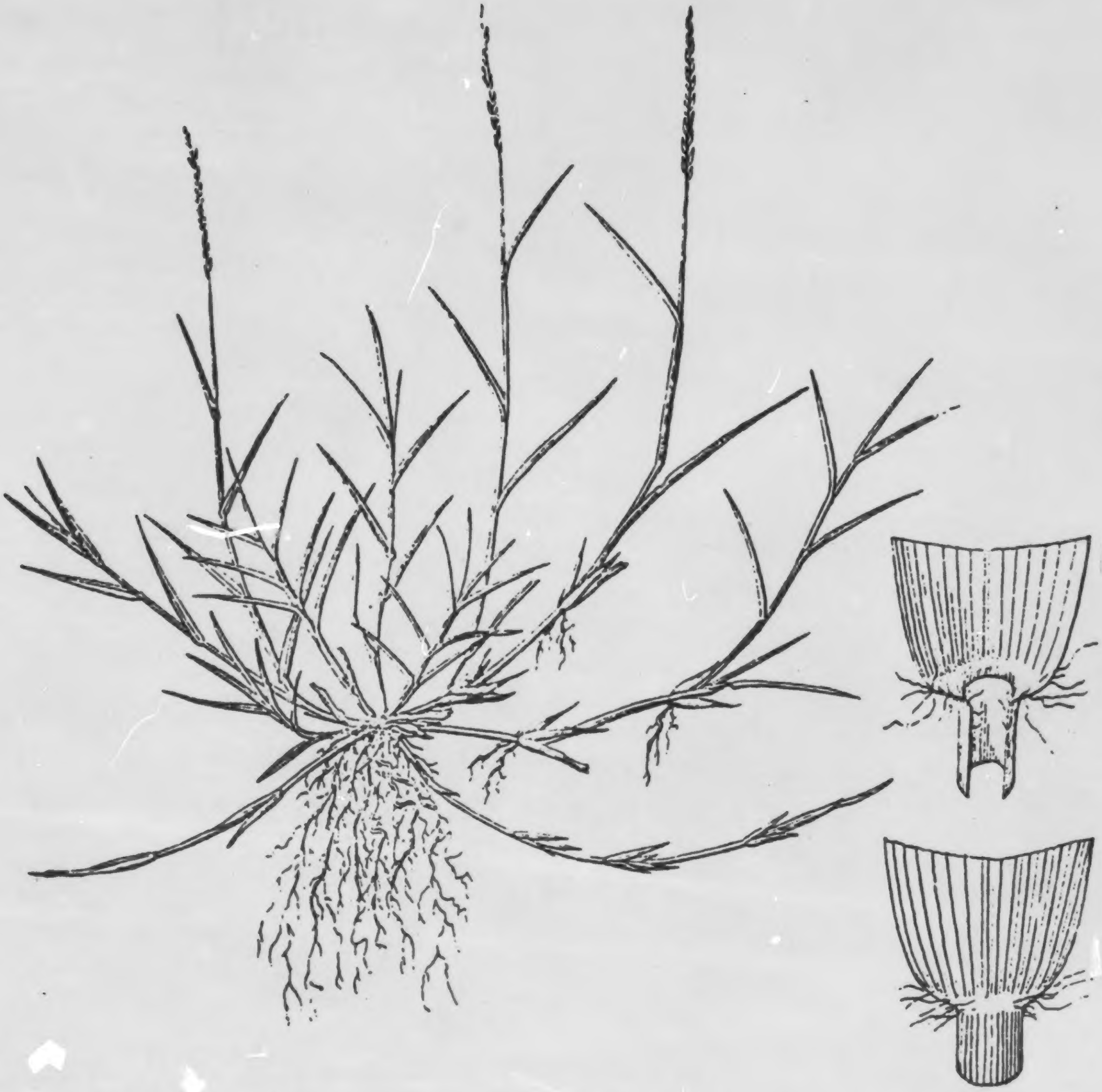
TM 6

BERMUDA GRASS



TM 7

ZOYSIAGRASS



TM 8

H-297-A

TURF GRASS PRODUCTION
UNIT XII

ASSIGNMENT SHEET #1—COLLECT AND IDENTIFY TURF GRASS PLANTS

Collect as many turf grass plants as possible and identify each plant according to either perennial or annual, cool or warm season. You should also be able to identify ligules, auricles, collars, and leafbuds. When finished turn in to your instructor for his/her evaluation.

Place an "X" in the blanks indicating the proper identification for the particular plant.

	1	2	3	4	5 Lingules			6 Auricles			7 Collars			8 Leaf Bud	
	Perenial	Annual	Cool Season	Warm Season	Menbrance	Hairy	Absent	Long Claw-Like	Short Stubby	Absent	Continuous	Divided	Broad in Narrow	Rolled in the Bud	Folded in the Bud

TURF GRASS PRODUCTION
UNIT XII

JOB SHEET #1—PREPARE SEEDBED

I. Equipment

  A. Spade

  B. Mechanical spreader

  C. Steel bow rake

  D. Spring rake

  E. Soil test kit

  F. Fertilizer 10-6-4 and lime

II. Procedure

  A. Test soils pH and nutrient content

  B. Grade area to appropriate level

  C. Add lime if needed with mechanical spreader

  D. Spade top 8 to 10 inches of soil

  E. Rake area to remove sticks, rocks, or debris

  F. Add fertilizer to soil by hand or using mechanical spreader

  G. Rake into soil

  H. Add soil conditioner

TURF GRASS PRODUCTION
UNIT XII

JOB SHEET #2—SPOT SEED AN ESTABLISHED LAWN

I. Equipment

  A. Steel bow rake

  B. Grass seed

  C. Water

II. Procedure

  A. Select area to renovate

  B. Remove all old grass and weeds

  C. Rake to loosen soil 1 to 2 inches

  D. Mix in seed with rake 1/2 inch

  E. Use sole of shoe to firm soil

  F. Sprinkle lightly with water

TURF GRASS PRODUCTION
UNIT XII

JOB SHEET #3—SEED A NEW LAWN

I. Equipment

- A. Mechanical spreader
- B. Water ballast roller
- C. Spring rake
- D. Grass seed
- E. Mulch (straw or hay)

II. Procedure

- A. Select area to be seeded
- B. Review suitable lawn mixtures and rate of aplication
- C. Light rake area to kill germinating weeds
- D. Divide seed into two even lots
- E. Sow 1/2 seed evenly in one direction by hand or with mechanical spreader
- F. Sow the other 1/2 seed evenly at right angle to the first
- G. Rake surface lightly
- H. Roll soil with water ballast roller
- I. Cover area with mulched, weed-free straw
- J. Water lightly

TURF GRASS PRODUCTION
UNIT XII

JOB SHEET #4—MOWING GRASS PROPERLY

I. Equipment

   A. Rotary lawnmower

   B. Spring rake

   C. Grinder

   D. Gasoline

II. Procedure

   A. Decide on height to mow

   (NOTE: You will need to determine dominant specie[illegible] grass.)

   B. Sharpen lawnmower blade if needed

   C. Set lawnmower blade to proper height

   D. Cut lawn in strips the length of the area

   E. Cut grass overlapping 4 to 6 inches

   F. Rake cut area

   G. Clean mower and dispose of clippings properly

TURF GRASS PRODUCTION
UNIT XII

TEST

1. Match the terms on the right to the correct definition.

____ a. Vegetative plant that is prepared for planting by chopping or shredding so that it can be planted uniformly

____ b. Offspring of two parents which differ in one or more heritable characters

____ c. Stem that grows under the soil surface like a root; has well developed nodes and internodes

____ d. Plant which completes its life cycle within one year and then dies

____ e. Grasses which grow during the summer and early fall

____ f. "Spot sod;" essentially to 3' or 4' inch cubes of cut sod into a prepared seedbed at spaced intervals

____ g. Not in an active state of growth

____ h. Modified stem that grows horizontally above the soil surface, taking root when it branches out from parent plant and touches the ground

____ i. Plant which lives three or more years

____ j. Thick, short plant growth along with the soil

____ k. Grasses which grow during the fall, winter, or spring

1. Rhizome
2. Annual
3. Warm season grasses
4. Plug
5. Dormant
6. Cool season grasses
7. Sod
8. Perennial
9. Stolon
10. Hybrid
11. Sprig

2. Identify the parts of a grass plant.

a.

b.

c.

d.

e.

f.

g.

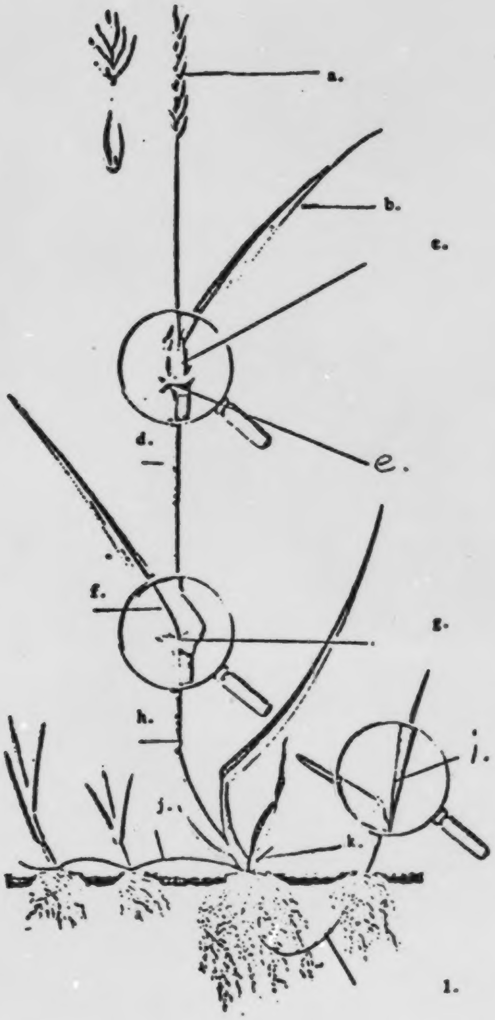
h.

i.

j.

k.

l.


a.
b.
c.
e.
d.
f.
g.
h.
i.
j.
k.
l.

3. Match the grass parts on the right to the correct descriptions.

____ a. Projects from either side of the collar

____ b. Joins stem at junction of blade and sheath

____ c. Cylindrical shape

____ d. Rolled or folded in bud

____ e. Outerside of leaf junction of blade and sheath

____ f. Lighter color

____ g. Lower leaf around stem

____ h. Separate from plant by collar and ligule

____ i. Broad and narrow shape

____ j. Smooth and hairy

____ k. Outerside of leaf junction of blade and sheath

____ l. Varies in size, shape and type of tip

____ m. Tall short toothed shape

1. Blade
2. Sheath
3. Ligule
4. Auricle
5. Collar

4. Describe the seven turf grass plants listed below.

   a. Bluegrass
   b. Bentgrass
   c. Fine fescue
   d. Bermudagrass
   e. Zoysiagrass
   f. Tall fescue
   g. Ryegrass

5. Describe two methods of asexual turf propagation.

   a) Vegetative planting

   b. Spot seeding

6. Describe two methods of sexual turf propagation.

   a) Seed

   b) Dormant seeding

7. Demonstrate the ability to:

   a. Prepare a seed bed.

   b. Spot seed an established lawn.

   c. Seed a new lawn.

   d. Mow grass properly.

TURF GRASS PRODUCTION
UNIT XII

ANSWERS TO TEST

1. a. 11
   b. 10
   c. 1
   d. 2
   e. 3
   f. 4
   g. 5
   h. 9
   i. 8
   j. 7
   k. 6

2. a. Inflorescence (seed head)

   b. Blade

   c. Ligule

   d. Sheath

   e. Auricles

   f. Collar

   g. Node

   h. Stolon

   i. Crown

   j. Rhizome (underground stem)

3. a. 4
   b. 3
   c. 2
   d. 1
   e. 5
   f. 5
   g. 2
   h. 1
   i. 5
   j. 1
   k. 5
   l. 1
   m. 3

4. Description should include:
    - a. Bluegrass
        - 1) Adaptation
            - a) Temperate cool regions
            - b) Most diversified grass
            - c) Kentucky bluegrass most popular
        - 2) Characteristics
            - a) Dark blue-green color
            - b) Fine texture
            - c) Spreads by tillers and rhizomes
            - d) Grows on heavy, well-drained soil
        - 3) Maintenance
            - a. Mow at 2 to 3 inches
            - b. Cutting shorter than 2 inches will weaken turf
    - b. Bentgrass
        - 1) Adaptation
            - a) Cut extremely low
            - b) Use only on golf course greens
        - 2) Characteristics
            - a) Light to dark green color
            - b) Fine texture
            - c) Spread by stolons
            - d) Matting growth
            - e) Mix with other desirable grasses
        - 3) Maintenance—Mow at ¼ and 1 inch one to two time a week

c. Fine fescue
  1) Adaptation
    a) Designed for shady areas
    b) Germinates quickly
    c) Establishes quickly
    d) Protects slower growing plants
  2) Characteristics
    a) Medium green in color
    b) Spreads by tillers or rhizomes
    c) Seldom grows in pure stands
    d) Competes poorly with agressive turf grasses
  3) Maintenance—Mow regularly at 1½ to 2½ inches

d. Bermuda grass
  1) Adaptation
    a) Very adaptive
    b) Easy to maintain
    c) Dense turf
    d) Coarse stemming unless top dressed and brushed
  2) Characteristics
    a) Medium, dark green
    b) Spreads by stolons and rhizomes
    c) Aggressive, rapid recover from damage
    d) Cooler regions turns brown and into dormancy
    e) Grows well in sunny, well-drained, neutral soils

- 3) Maintenance
  - a) Improved turf mow at ¼ to 1 inch
  - b) Common turf mow at 1 to 2 inches
  - c) Mow 2 to 3 times per week

e. Zoysiagrass

- 1) Adaptation
  - a) Southern regions only
  - b) Last grass to turn green in spring
  - c) Slow development
  - d) Northern areas turns brown with first frost
- 2) Characteristics
  - a) Fine medium texture
  - b) Dark green color
  - c) Spreads by stolons and short rhizomes
  - d) Planted vegetatively
  - e) Requires adequate watering
- 3) Maintenance
  - a) Mow ½ to 1 inch
  - b) Fertilize frequently

f. Tall fescue

- 1) Adaptation
  - a) Low maintenance turf
  - b) Coarse turf
  - c) Grows in sun and shade
  - d) Withstands abuse of heavy traffic

2) Characteristics

a) Medium to dark green color

b) Limited tiller growth

c) Open turf

d) Grows in clumps

e) Deep root growth

f) Performs in periods of heavy moisture and extended drought

3) Maintenance

a) Mow at height of 2 to 3 inches

b) Use sharp mower blade

g. Ryegrass

1) Adaptation

a) High germination

b) Establish rapidly

c) Nurse crop (annual rye grass)

d) Winter kills easily (perennial ryegrass)

e) Conserves moisture (annual ryegrass)

2) Characteristics

a) Medium to coarse texture

b) Light to dark green color

c) Upper surface is veined, below is glossy

d) Spreads by tillers

3) Maintenance—Mow 1½ to 2½ inches

5 Description should include:

a. Vegetative planting—Limited to grasses producing an abundance of creep stems

b. Spot sodding

1) Set cubes of cut sod in seedbed

2) Sod 12 to 18 inches wide, 24 to 36 inches long, and ¾ to 1 inch thick

6. Description should include:

a) Seed

1) Most common

2) Broadcast on seed bed

b) Dormant seeding

1) Seed applied in fall or winter

2) Seed dormant through winter; germinates in spring

3) Early turf establishment

7. Performance skills evaluate to satisfaction of instructor.

TURF GRASS MANAGEMENT
UNIT XIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe methods of seed bed preparation the steps to sodding. The student should also be able to aerate a lawn and sod a lawn. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with turf grass management with the correct definitions.
2. Select from a list rules to follow when watering lawns.
3. List five factors to consider in watering new seed bed.
4. Select from a list factors justifying turf aeration.
5. List four factors to consider when selecting mowing height.
6. Distinguish between indicators of subsurface and surface active insects.
7. Describe the three steps to sodding.
8. Describe three reasons for watering lawns.
9. Describe two situations of root growth.
10. Describe disease identificaition and control.
11. Demonstrate the ability to :
    a. Aereate a lawn.
    b. Sod a lawn.

TURF GRASS MANAGEMENT
UNIT XIII
SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss unit information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Arrange field trip to identify turf grass maintenance equipment.

   H. Give test.

II. Student:

   A. Read objectives.

   B. Study information sheets.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   E. Participate in field trip.

   F. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheets

   C. Transparency masters

      1. TM 1—Depth of Water Required

      2. TM 2—Ideal Situation

      3. TM 3—Saturation

      4. TM 4—Lack of Moisture

    5. TM 5—Light Watering

  D. Job sheets

    1. Job Sheet #1—Aerate lawn

    2. Job Sheet #2—Sod a Lawn

  E. Test

  G. Answer to test

II. References:

A. Musser, H. B. *Turf Grass Management:* New York: McGraw-Hill, Inc., 1962.

B. *Professional Turf Seminar.* O. M. Scott and Sons Co., 1971.

TURF GRASS MANAGEMENT
UNIT XIII

INFORMATION SHEET

I. Terms and definitions

A. Aeration—Mixing of air with water or with soil to improve the environment of plants and other organisms

B. Top-dressing—Method of improving lawns by adding a mixture of sand, soil, and peat to the lawn in late spring or early fall to renovate stemmy or matted sod

C. Renovation—Specialized form of maintenance which includes practices used to improve turf which has deteriorated beyond normal maintenance operations

D. Compaction—State that results when soils are continually worked and compressed until its pore space is reduced to the point where plant growth is limited

E. Thatch—Tightly intermingled layer of living and dead stems, leaves, and roots or grasses which develop between the layer of green vegetation and the soil surface

F. Mulching—Method of spreading straw or weed-free hay over seeded areas to conserve moisture for good germination and as a protection against erosion

G. Grading—Any method of earthwork which changes the levels of the surface of the ground

H. Top-soil—Surface layer of soil; usually has the most desirable structure for plant growth

I. Brushing—Use of a brush attachment on mowers to assist in raising surface stolons so they are cut off in mowing

II. Watering rules

A. Begin watering program early

B. Apply approximately 1 to 1½ inch of water per week

C. Make 2 to 3 applications a week

D. Sandy soils require ½ to ¾ inches more per application

E. Avoid extremes in watering

F. During heat periods, water to create a cooling effect

INFORMATION SHEET

III. Watering a new seedbed (Transparency 1)

  A. Water immediately

  B. Water twice a day

  C. When seedlings develop reduce watering

  D. Sprinkle gently

  E. Amount depends on soil

IV. Turf aeration

  A. Provides protected lodging for seeds

  B. Increases infiltration and efficiency of water, air, and nutrients into soil surface

  C. Stimulates new growth by encouraging healthy root development

  D. Decreases effort required to propel turf equipment

  E. Decreases possibility of disease and insect incidence

V. Mowing height

  A. Grasses grow from the base of the head

  B. Depends mainly on grass plant morphology and use

  C. Most grass species should be mowed frequently

  D. Seasonal and climatic conditions

  E. Removal of clippings is not critical if turf is mowed regulary

  F. Alternate mowing patterns

VI. Indicators of subsurface and surface active insects

  A. Subsurface active insects

  Examples: billbug, grubs, nematodes, white grubs

    1. Grass roots are chewed off just below the soil surface

    2. Turf can be rolled back

    3. Individual plants can be pulled from the soil

INFORMATION SHEET

4. Moles, skunks and raccoons destroy turf searching for grubs

5. General thinning of turf

B. Indicators of surface active insects

Examples: army worms, cutworm, sod bedworms

1. Grass blades or complete plants are chewed off

2. Small worms in the grass

3. Birds feed on the turf and peck holes in grass as they search for insects

4. Chewed up grass

5. Small moths are observed

VII. Sodding procedure

A. Site preparation

1. Drainage

a. Tile

b. Natural drainage

2. Soil

a. Heavy clay cultivate at least 8 inches

b. Culcines clay peat used to create friable mixture

3. Fertilizer

a. Mix top two inches

b. Encourage rapid knitting of soil

B. Installation

1. Watering—water heavily

2. Laying sod

a. Begin at one end or from side to side

b. Stagger joints

INFORMATION SHEET

C. Maintenance

1. Watering
    a. Daily
    b. Lift at corners to observe
2. Mowing
    a. Mow as needed
    b. Remove less than 1/3 of plant

VIII. Watering lawns

A. Germination
    1. Frequent
    2. Light watering

B. Photosynthesis—water plus sunlight and carbon dioxide used in photosynthesis

C. Turgidity
    1. Allow plant to remain upright
    2. Lack of water will cause wilting

D. Resilience to resist foot travel

E. Coolant—Keep lawn temperature down

F. Seeding—Mix seed ¼ inch of soil

G. Mulch
    1. Weed free
    2. Uniform

IX. Root growth

A. Ideal (Transparency 2)
    1. Adequate air space
    2. Moisture at all depth

B. Saturation (Transparency 3)

INFORMATION SHEET

   1. Saturated with water
   2. Air movement is blocked
   3. Grass blades become limp
   4. Roots cease penetration
   5. Root remains close to surface

C. Lack of moisture (Transparency 4)

   1. Growth is stunted
   2. Feeder roots first to die
   3. Roots thrive at lower level

D. Light watering (Transparency 5)

   1. Inadequate deep rooting
   2. Plant in depleted condition

X. Disease identification and control

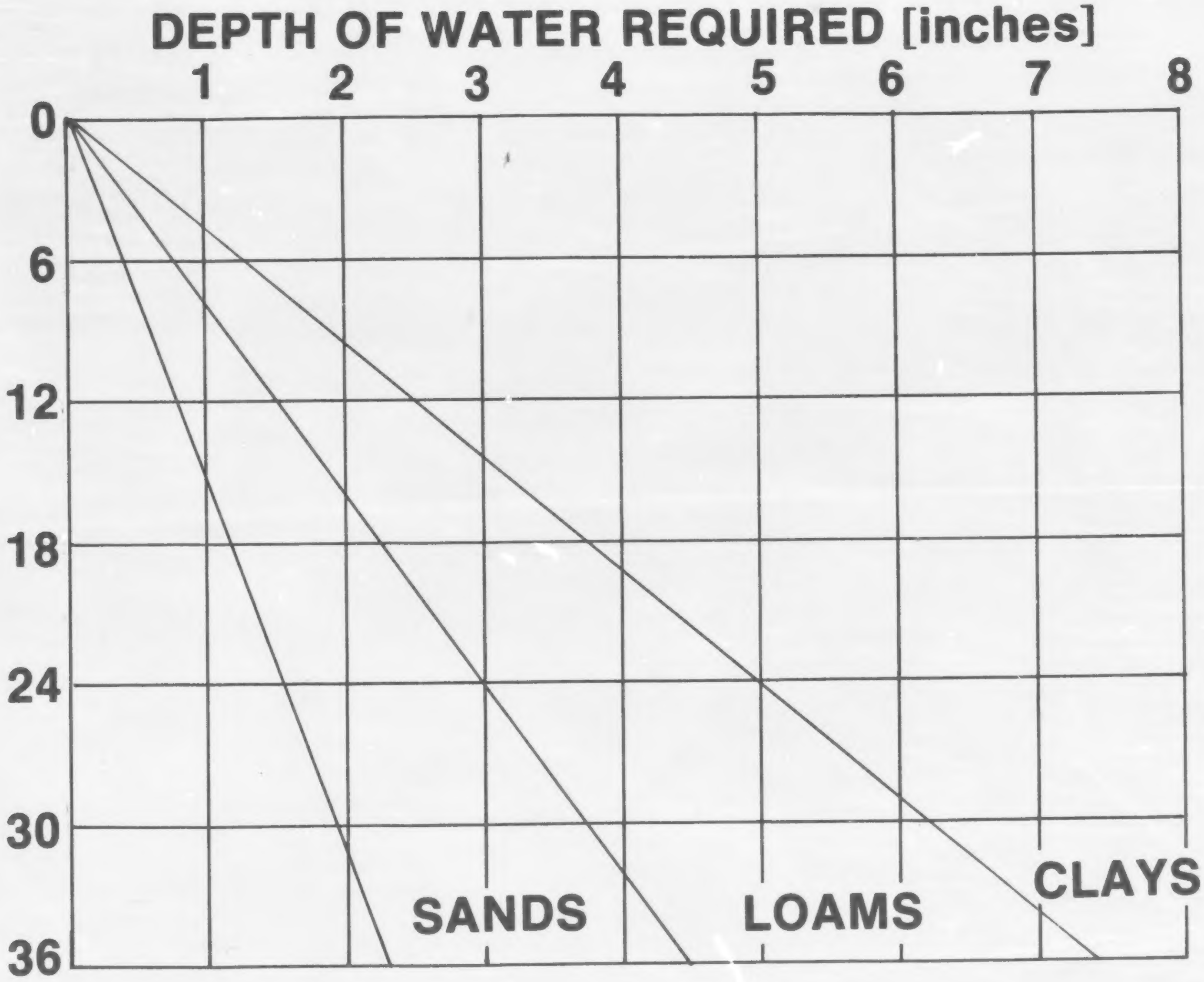
A. Origin and spread of disease caused by parasitic forms of plant life called fungi

B. Principle components to produce a plant disease

   1. Host plant
   2. Disease organism
   3. Method of distribution produce disease
   4. Proper environment

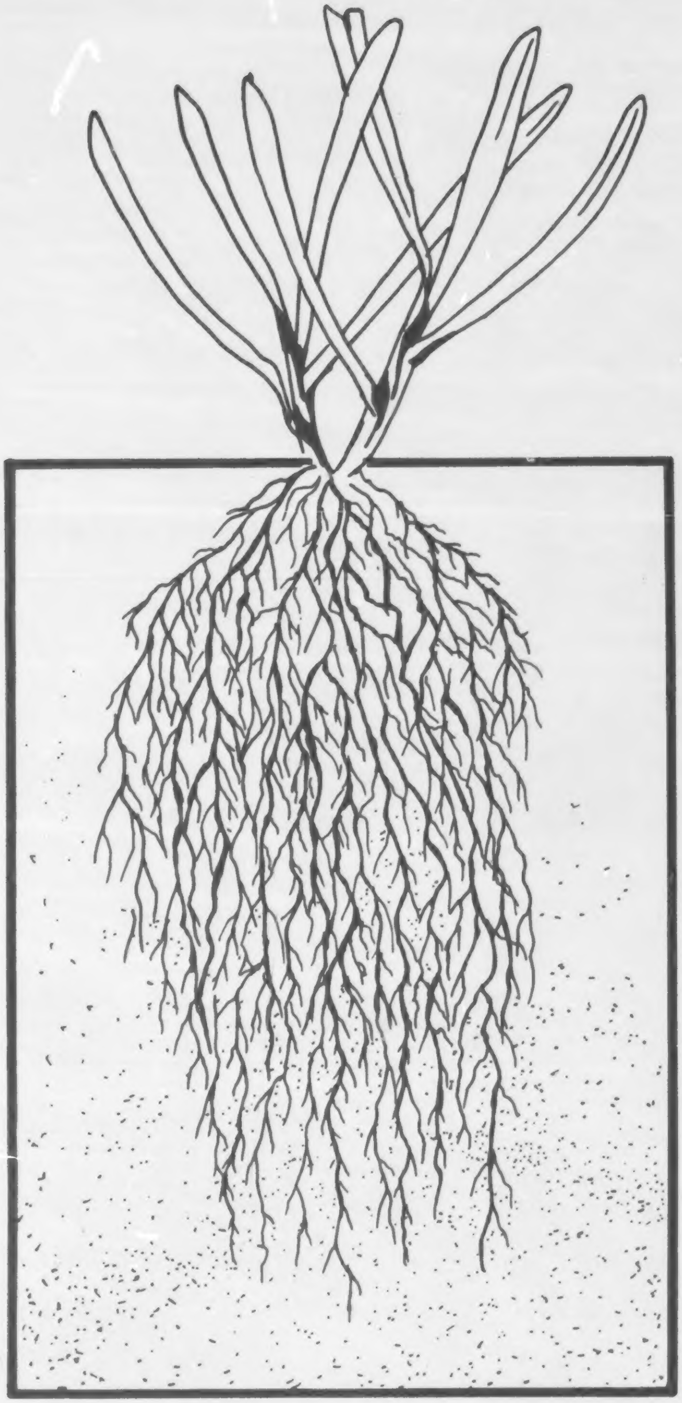
C. Disease epidemics will not develop if any one of these components is missing

D. Grasses are susceptible to turf disease the year around


DEPTH OF WATER REQUIRED [inches]
1
2
3
4
5
6
7
8
0
6
12
18
24
30
36
SANDS
LOAMS
CLAYS

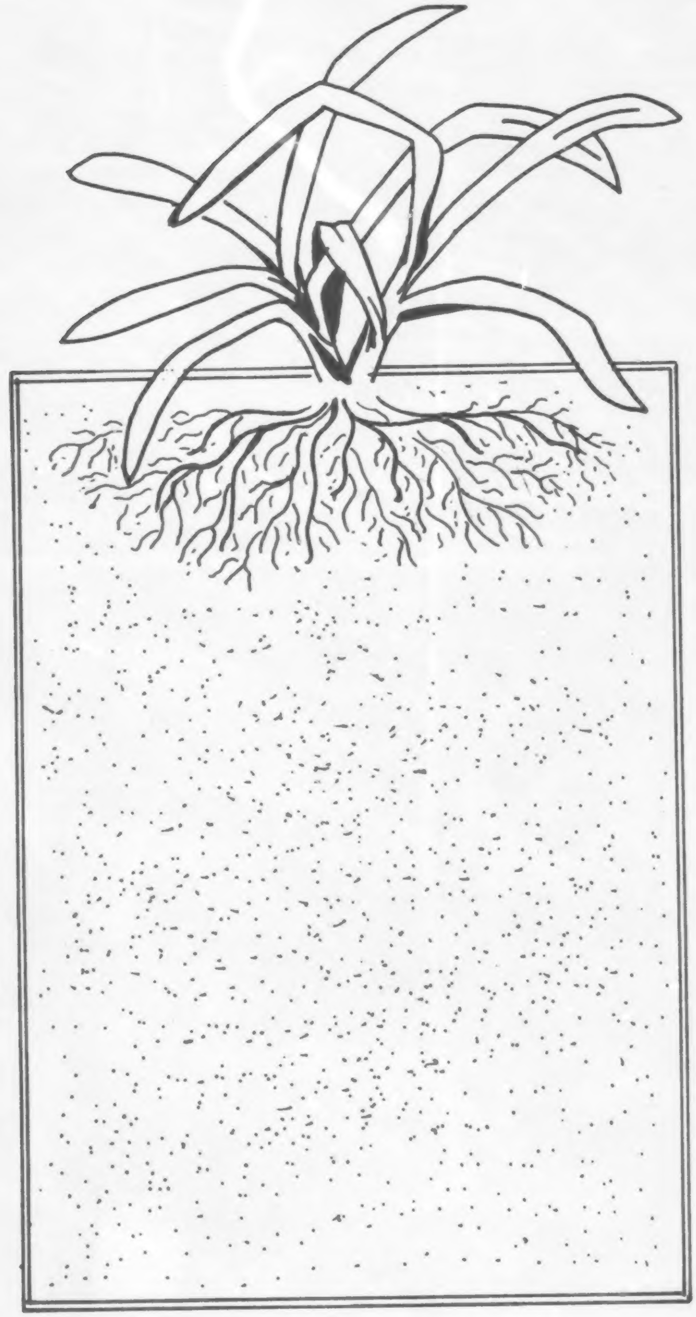
TM 1

IDEAL SITUATION



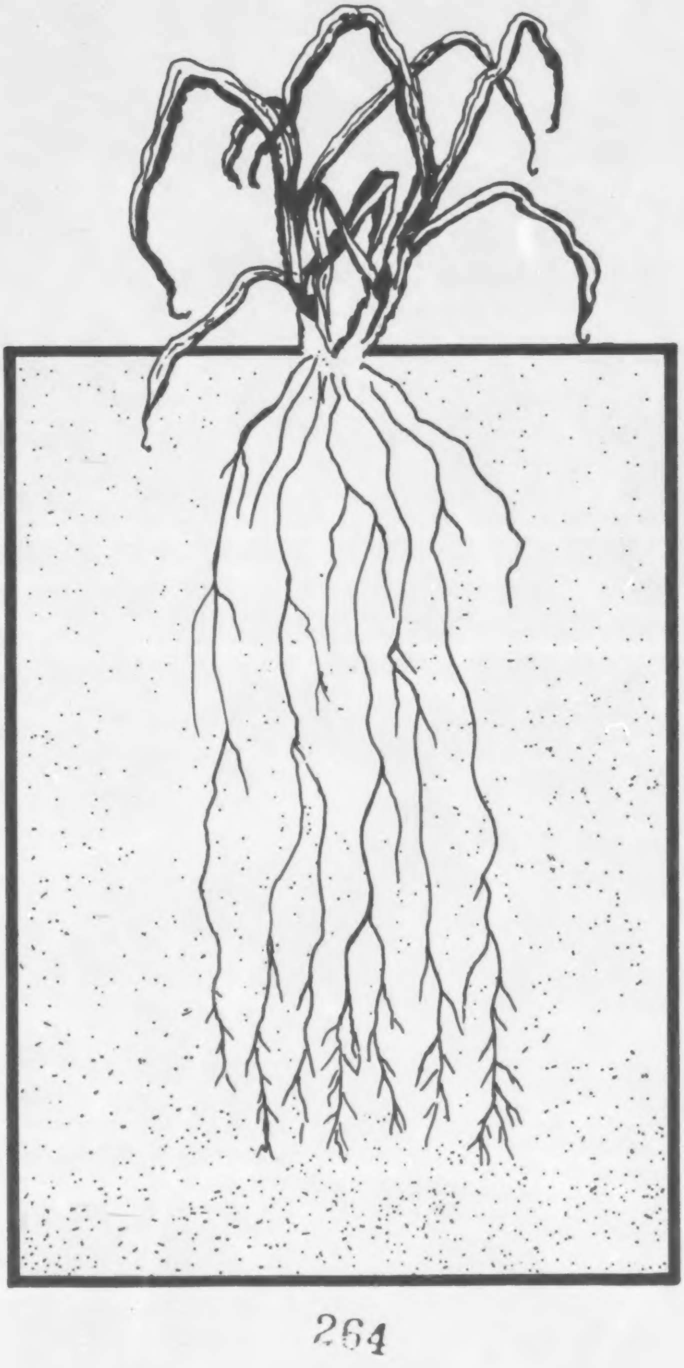
TM 2

SATURATION



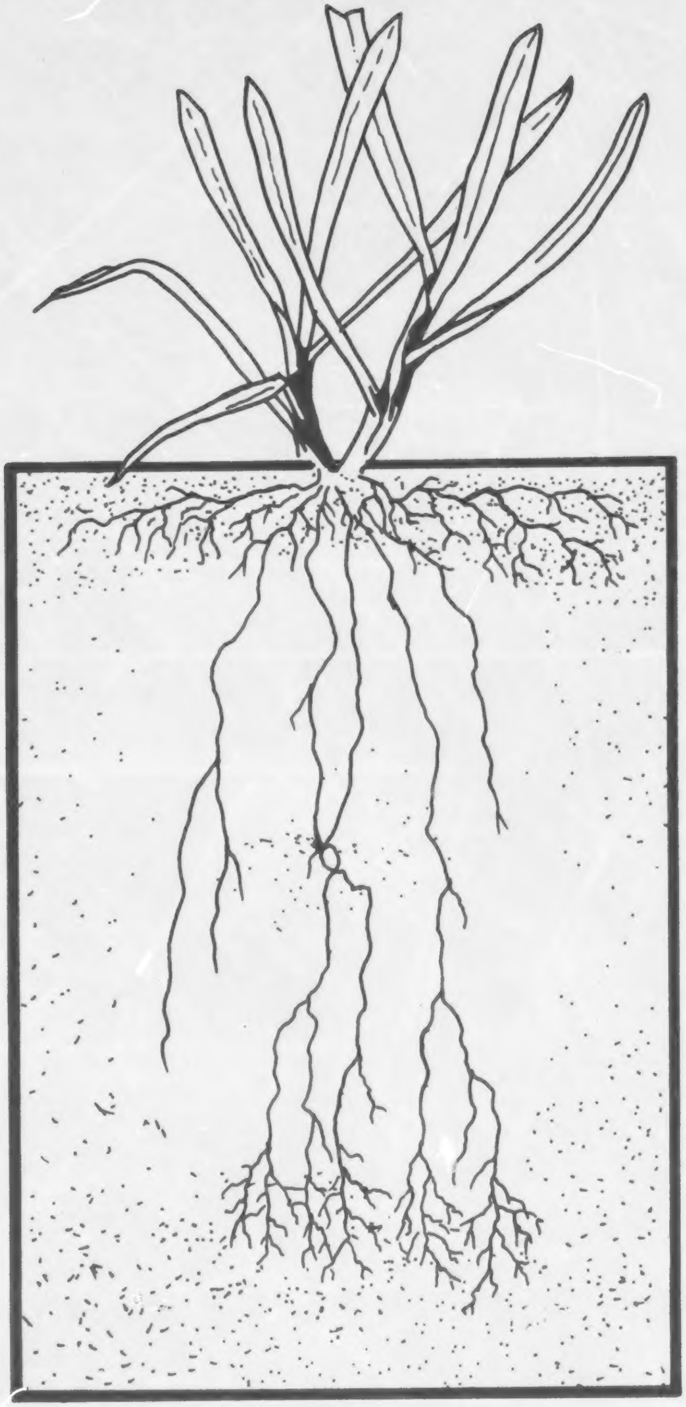
TM 3

LACK OF MOISTURE



TM 4

LIGHT WATERING



TM 5

TURF GRASS MANAGEMENT
UNIT XIII

JOB SHEET #1—LAWN AERATION

I. Equipment

   A. Lawn roller with aerator spike

   B. Lime

   C. Fertilizer

II. Procedure

   A. Mow lawn 1 to 1½ inches high and remove clippings

   B. Roll lawn in one direction with spike roller

   C. Overlap slightly

   D. Repeat spike rolling at 90 degrees to cross the line and holes by the first rolling operation

   E. Fill lime spreader

   F. Adjust lime spreader to correct adjustment

   G. Water lawn

   H. Clean and store equipment

TURF GRASS MANAGEMENT
UNIT XIII

JOB SHEET #2—SOD A LAWN

I. Equipment

   A. Water ballaster roller

   B. Sod

   C. Fine screened soil

II. Procedure

   A. Prepare soil

   B. Purchase sod from nursery

   C. Lay sod in strips on top of the prepared soil

   D. Fit sod closely together

   E. Stagger the strips so length sizes are different as you lay them down

   F. Fill all cracks between sod strips with fine screened soils

   G. Soak fine soil with water

   H. Roll sod with water ballaster roller when sod dries

TURF GRASS MANAGEMENT
UNIT XIII

TEST

1. Match the terms on the right to the correct definitions.

____ a. Use of a brush attachment on mowers to assist in raising surface stolons so they are cut off in moving

____ b. Any method of earthwork which changes the levels of the surface of the ground

____ c. A tightly intermingled layer of living and dead stems, leaves, and roots or grasses which develop between the layer of green vegetation and the soil surface

____ d. Specialized form of maintenance which includes practices used to improve turf which has deteriorated beyond normal maintenance operations

____ e. Mixing of air with water or with soil to improve the environment of plants and other organisms

____ f. Surface layer of soil; usually has the most desirable structure for plant growth

____ g. Method of spreading straw or weed-free hay over seeded areas to conserve moisture for good germination and as a protection against erosion

____ h. State that results when soils are continually worked and compressed until its pore space is reduced to the point where plant growth is limited

____ i. Method of improving lawns by adding a mixture of sand, soil, and peat to the lawn in late spring or early fall to renovate stemmy or matted sod

1. Aeration
2. Top-dressing
3. Renovation
4. Compaction
5. Thatch
6. Mulching
7. Grading
8. Top-soil
9. Brushing

2. Select from the list below rules to follow when watering lawns by placing an X by the true statements.

   ____ a. Begin watering program early

   ____ b. Water every other week

   ____ c. Apply approximately 1 to 1½ inches of water per week

   ____ d. Clay soils require 1 inch or more per application

   ____ e. Avoid extremes in watering

   ____ f. During wet periods mildew will develop

3. List the five factors to consider when watering a new seed bed.

   a.

   b.

   c.

   d.

   e.

   f.

4. Select from the list below factors justifying turf aeration. Place an "X" in the correct blanks.

   ____ a. Provides protected lodging for seeds

   ____ b. Stimulates new growth by encouraging healthy root development

   ____ c. Stimulate old and new growth by encouraging healthy root development

   ____ d. Turf aeration should only be done within the top 3 inches

   ____ e. Increases micronutrients availability in the soil

5. List four factors to consider when selecting mowing height.

a.

b.

c.

d.

6. Distinguish between indicators of subsurface (SS) and surface (S) active insects. Place the correct letter in the blanks provided.

____ a. Grass blades or complete plants are chewed off

____ b. Small moths are observed

____ c. General thinning of turf

____ d. Turf can be rolled back

____ e. Chewed up grass

____ f. Moles, skunk and raccoons destroy turf searching for grubs

____ g. Grass roots are chewed off just below the sod surface

____ h. Birds feed in the turf and peck holes in grass as they search for insects

____ i. Small worms in the grass

____ j. Individual plants can be pulled from the soil

7. Describe three steps to sodding

a.

b.

c.

8. Describe the following reasons for watering lawns.
   a. Germination
   b. Photosynthesis
   c. Turgidity

9. Describe two situations of root growth.
   a. Saturation
   b. Ideal

10. Describe disease identification and control

11. Demonstrate the ability to:
    a. Aerate a lawn.
    b. Sod a lawn.

TURF GRASS MANAGEMENT
UNIT XIII

ANSWERS TO TEST

1. a. 9
   b. 7
   c. 5
   d. 3
   e. 1
   f. 8
   g. 6
   h. 4
   i. 2

2. a, c, e

3. a. Water immediately
   b. Water twice a day
   c. When seedlings develop, reduce watering
   d. Sprinkle gently
   e. Amount depends on soil

4. a, b

5. Any four of the following:
   a. Grasses grow from the base of the head
   b. Depends mainly on grass plant morphology and use
   c. Most grasses species should be mowed frequently
   d. Seasonal and climatic conditions
   e. Removal of clippings is not critical if turf is mowed regularly
   f. Alternate mowing patterns

6. a. S
   b. S
   c. SS
   d. SS
   e. S
   f. SS
   g. SS
   h. S
   i. S
   j. SS

7. Description should include:
   a. Site preparation
      1) Drainage
         a) Tile
         b) Natural drainage
      2) Soil
         a) Heavy clay cultivate at least 8 inches
         b) Culcines clay peat used to create friable mixture
      3) Fertilizer
         a) Mix top two inches
         b) Encourage rapid knitting of soil
   b. Installation
      1) Watering—water heavily
      2) Laying sod
         a) Begin at one end or from side to side
         b) Stagger joints
   c. Maintenance
      1) Watering
         a) Daily
         b) Lift at corners to observe
      2) Mowing
         a) Mow as needed
         b) Remove less than ⅓ of plant
8. Description should include:
   a) Germination
      1) Frequent
      2) Light watering

- b) Photosynthesis—water plus sunlight and carbon dioxide used in photosynthesis
- c) Turgidity
    - 1) Allow plant to remain upright
    - 2) Lack of water will cause wilting

9. Description should include:
    - a) Saturation
        - 1) Saturated with water
        - 2) Air movement is blocked
        - 3) Grass blades become limp
        - 4) Roots cease penetration
        - 5) Root remains close to surface
    - b) Ideal
        - 1) Adequate air space
        - 2) Moisture at all depth

10. Description should include:
    - a) Origin and spread of disease caused by parasitic forms of plant life called fungi
    - b) Principle components to produce a plant disease
        - 1) Host plant
        - 2) Disease organism
        - 3) Method of distribution produce disease
        - 4) Proper environment
    - c) Disease epidemics will not develop if any of these components is missing
    - d) Grasses are susceptible to turf disease the year around

.1. Performance skills evaluated to satisfaction of instructor.

IRRIGATION
UNIT XIV

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between the advantages and disadvantages of various methods of irrigation. This knowledge will be evidenced through scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with irrigation with their definitions.
2. List five factors about surface irrigation.
3. Distinguish between the advantages and disadvantages of surface irrigation.
4. Distinguish between advantages and disadvantages of sprinkler irrigation.
5. List three ways water is distributed in sprinkler irrigation.
6. Select from a list true statements about subsurface irrigation.
7. Distinguish between advantages and disadvantages of subirrigation.
8. Select from a list true statements about trickle irrigation.
9. Distinguish between advantages and disadvantages of trickle irrigation.
10. Select from a list true statements about irrigation efficiency.
11. Describe one kind of automatic greenhouse watering system.
12. Describe two methods of distributing water by surface irrigation.
13. Demonstrate the ability to measure watering rates of lawn hoses.

IRRIGATION
UNIT XIV
SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information sheet.
- C. Make transparency.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in the job sheet.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheets.
- C. Demonstrate the ability to complete the procedures outlined in the job sheet.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
- C. Transparency master: TM—1 Sprinkler Irrigation System
- D. Job Sheet#1—Measure Watering Rates of Lawn Hoses
- E. Test
- F. Answers to test

II. References:

- A. *Agronomy Guide*. Columbus, Ohio: Cooperative Extension Service Bulletin 472, Extension Office of Information, The Ohio State University.
- B. Clark, David E. *Basic Gardening III, shortened.* Menlo Park, California: Sunset Books, 1974.

IRRIGATION
UNIT XIV

INFORMATION SHEET

I. Terms and definitions

A. Trickle irrigation—Water loss by evaporation and transpiration

B. Percolation—To pass or cause to pass through fine openings

C. Permeable—Allowing passage of fluids

D. Syphon—Bent tube used for transferring liquids from a higher to lower level over an intervening elevation by making use of atmospheric pressure

E. Tensiometer—Measures tension at which water is held to the soil

F. Topography—Lay of the land

G. Water table—Upper level of water-saturated soil

H. Soaker—Perforated hose that allows water to soak into soil at a low, uniform rate

II. Factors about surface irrigation

A. Utilized mostly in arid and semi-arid regions, but sometimes in humid, temperate regions

B. Topography must be level

C. Conveyed to the field in open ditches or tiles at slow speed

D. Pipelines may be used, eliminating losses due to seepage and evaporation

E. Distribution of water is accomplished by various control structures or by syphons

F. Too rapid a flow causes leaching of water-soluable nutrients

G. Too rapid a flow will cause erosion

H. Drainage canals must be provided to prevent ponding

III. Surface irrigation

A. Advantages

1. Less power required than other methods

2. Minimal water loss by evaporation

INFORMATION SHEET

B. Disadvantages

   1. Depends on gravity flow
   2. Can have a negative effect on soil structure
   3. Can result in loss of soil aeration because of the possibility of puddling

IV. Sprinkler irrigation

A. Advantages

   1. Application rate can be controlled
   2. Even application
   3. Efficient use of water
   4. Reduces runoff, erosion, and disturbed soil conditions
   5. Used on steep terrains
   6. Means of providing water in humid climates
   7. Full use of the land
   8. Lower labor cost

B. Disadvantages

   1. Initial cost is high
   2. Power requirements are high
   3. Wind can result in uneven water distribution
   4. Evaporation can cause high water loss

V. Methods of distributing water by sprinkler irrigation

A. Nozzles

B. Perforated pipe

C. Rotating sprinkler heads

INFORMATION SHEET

VI. Facts about subsurface irrigation

  A. Creates and maintains an artificial water table

  B. Ground must be level

  C. Subsurface soil must be permeable enough to permit the rapid movement of water laterally and vertically

  D. Impervious layer must be available to prevent the loss of water laterally and vertically

  E. Distribution of main ditches and lateral ditches permits the artificial water table to be raided or lowered by pumping water into or out of the system

VII. Subirrigation

  A. Advantages

    1. Use of water is efficient

    2. Evaporation loss is minimized

    3. Power requirements are minimal

  B. Disadvantages

    1. Rainfall can cause flooding and crop damage

    2. Utilized in a selective area

    3. Results in a soluable buildup

VIII. Facts about trickle irrigation

  A. Consists of network of water-conducting plastic tubes with individual lines feeding each pot

  B. Used for automatic watering of plants in greenhouses

  C. Automated for watering and fertilization of the plant

  D. Automation device may consist of a scale to weigh the pot

  E. Tubes can be disconnected and plugged for individual plant's requirements

IX. Trickle irrigation

  A. Advantages of trickle irrigation

INFORMATION SHEET

1. Provides uniform watering and fertilization
2. In arid regions less evaporation occurs; therefore, less salt accumulates on soil surface
3. With high concentration of water around the individual plant, the salts can be leached out
4. Conserves water by restricting it to the root zone in spaced plantings

B. Disadvantages

1. Tubes may become plugged
2. Installation is costly
3. Tubes can come out of pots easily

X. Facts about irrigation efficiency

A. Amount of water applied must be based on the irrigation efficiency

B. Amount of water applied should be at root depth

C. Amount of water applied should be sufficient to bring soil to "field capacity"

D. Water should be applied when 60% of the available water in the root zone is depleted

E. Amount of water applied should be related to the soil fertility level for the most efficient use

F. Maximum benefits of irrigation are dependent upon the existence of a readily available nutrient supply

XI. Kinds of automatic greenhouse watering systems

A. Overhead

1. Water applied to surface of soil
2. Hand-held hose
3. Skinner system uses perforated pipe that produces a fine spray
4. Soakers
5. Trickle system uses plastic hoses to each pot

INFORMATION SHEET

6. Gates system uses small spray nozzel on perimeter of bench

B. Subirrigation

1. Water applied under surface of soil
2. Tile line or perforated pipe located in bottom of watertight bench
3. Watertight bench where pots are located is flooded
4. Water moves upward into root zone by capillary action

XII. Methods of distributing water by surface irrigation

A. Flood Irrigation

1. Entire field is covered
2. Used for horticultural crops that can tolerate excessive water

B. Furrow irrigation

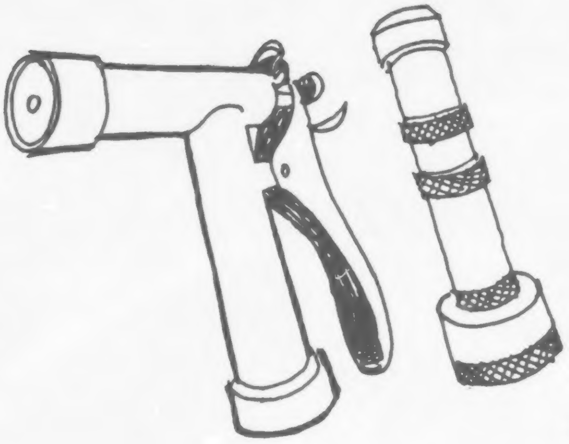
1. High labor costs
2. Efficient in water utilization

C. Soaker irrigation

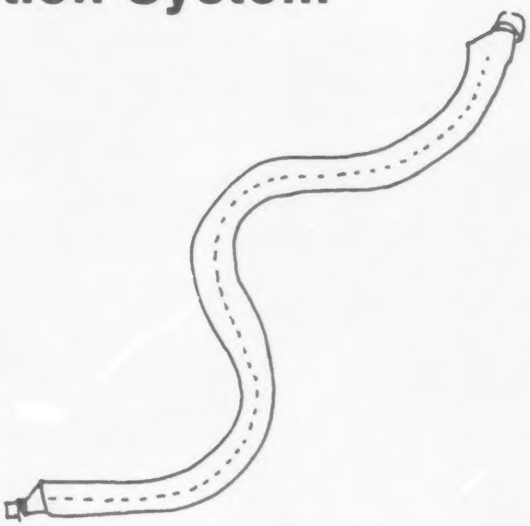
1. Used in rolling land and closely growing crops
2. Soakers provide a form of surface irrigation

H-359-A

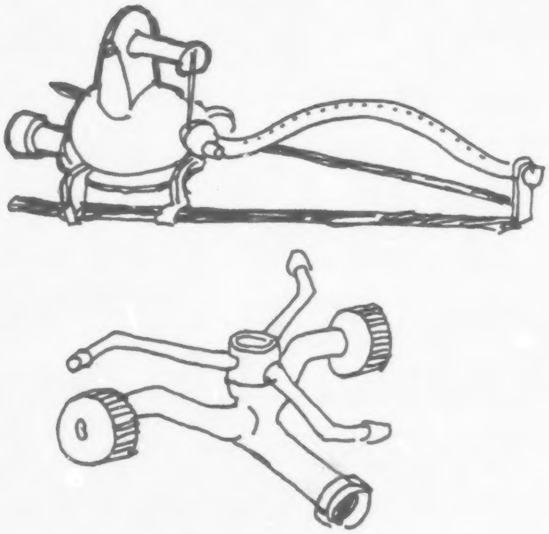
Sprinkler Irrigation System



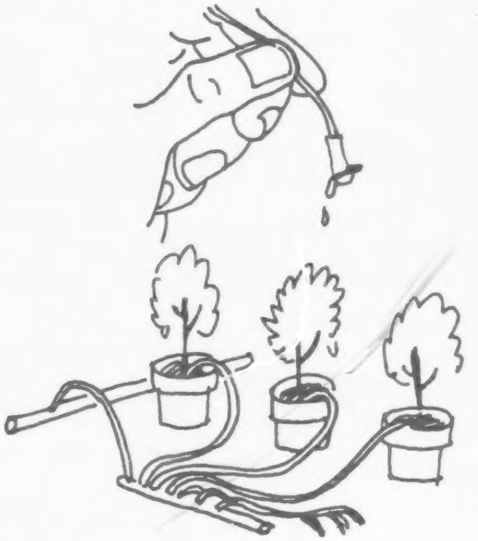
Nozzles



Perforated Pipe



Rotating Sprinkler Heads



Trickle Irrigation

TM 1

IRRIGATION
UNIT XIV

JOB SHEET #1—MEASURE WATERING RATES OF LAWN HOSES

I. Equipment

   A. Three lengths of hose

      1. Fifty feet long

      2. Seventy-five feet long

      3. One hundred feet long

   B. Three diameters for each hose

      1. ⅝ inch

      2. ¾ inch

      3. ½ inch

   C. One five gallon can

   D. Stopwatch

II. Procedure

   A. Fill the five gallon can with water from each hose

   B. Time the rate with the stopwatch

   C. Observe which hose carries the most water in the shortest time

   D. Observe number of gallons per minute for each hose

   (NOTE: Chart your results.)

IRRIGATION
UNIT XIV

TEST

1. Match the terms on the right to the correct definitions.

   ____ a. Lay of the land

   ____ b. Water loss by evaporation and transpiration

   ____ c. Bent tube used for transferring liquids from a high to a lower level over an intervening elevation by making use of atmospheric pressure

   ____ d. Measures tension at which water is held to the soil

   ____ e. Perforated hoses that allow water to soak into the soil at a low, uniform rate

   ____ f. To pass or cause to pass through fine openings

   ____ g. Upper level of a water-saturated soil

   ____ h. Allowing passage of fluids

   1. Trickle irrigation
   2. Tensiometer
   3. Percolation
   4. Permeable
   5. Water table
   6. Soakers
   7. Syphon
   8. Topography

2. List five factors about surface irrigation.

   a.

   b.

   c.

   d.

   e.

3. Distinguish between the advantages and disadvantages of surface irrigation. Place an "A" by the advantages and a "D" by the disadvantages.

   ____ a. Depends on gravity flow

   ____ b. Can have a negative effect on soil structure

____ c. Can result in loss of soil aeration because of the possibility of puddling

____ d. Less power required than other methods

____ e. Minimal water loss by evaporation

4. Distinguish between the advantages and disadvantages of surface irrigation. Place an "A" by the advantages and a "D" by the disadvantages.

____ a. Even application

____ b. Lower labor cost

____ c. Initial cost is high

____ d. Used on steep terrain

____ e. Power requirements are high

____ f. Wind can result in uneven water distribution

____ g. Evaporation can cause high water loss

____ h. Means of providing water in humid climates

5. List three ways water is distributed in sprinkler irrigation.

a.

b.

c.

6. Select from the list below true statements about sursurface irrigation by placing an "X" by the true statements.

____ a. Creates and maintains an artificial water table.

____ b. Ground must be level

____ c. Subsurface soil must be permeable enough to permit rapid movement of water laterally and vertically

____ d. An impervious layer must be available to prevent the loss of water through deep percolation

____ e. Water table cannot be lowered or raised

7. Distinguish between advantages and disadvantages of subirrigation by placing an "A" by the advantages and a "D" by the disadvantages.
   - ____ a. Rainfall can cause flooding and crop damage
   - ____ b. Use of water is efficient
   - ____ c. Evaporation loss is minimized
   - ____ d. Utilized in a selective area
   - ____ e. Results in a soluable buildup
   - ____ f. Power requirements are minimal

8. Select from the list below true statements about trickle irrigation. Place an "X" by the true statements.
   - ____ a. Used on huge farms in the semi-arid regions
   - ____ b. Used for automatic watering of pots in greenhouses
   - ____ c. Consists of a network of water-conducting plastic tubes with individual lines feeding each pot
   - ____ d. Cannot be used for fertilization
   - ____ e. Tubes, can be disconnected and plugged for individual plant requirements

9. Distinguish between the advantages and disadvantages of trickle irrigation by placing an "A" by the advantages and a "D" by the disadvantages.
   - ____ a. Tubes may become plugged
   - ____ b. Installation is costly
   - ____ c. Provides uniform watering and fertilization
   - ____ d. In arid regions less evaporation occurs: therefore, less salt accumulates in soil surface
   - ____ e. With high concentration of water around individual plant the salt can be leached out
   - ____ f. Tubes can come out of pots easily
   - ____ g. Conserves water by restricting it to the root zone in spaced planting

11. Describe one kind of automatic greenhouse watering system.

12. Describe the methods of distributing water by surface irrigation as given below.
    a. Flood irrigation
    b. Soaker irrigation

13. Demonstrate the ability to measure watering rates of lawn hoses.

IRRIGATION
UNIT XIV

ANSWERS TO TEST

1. a. 8
   b. 1
   c. 7
   d. 2
   e. 6
   f. 3
   g. 5
   h. 4

2. Any five of the following:
   a. Utilized mostly in arid and semi-arid regions, but sometimes also in humid, temperate regions
   b. Topography must be level
   c. Conveyed to the field in open ditches or tiles at slow speed
   d. Pipelines may be used, eliminating losses due to seepage and evaporation
   e. Distribution of water is accomplished by various control structures or by syphons
   f. Too rapid a flow will cause leaching of water-soluable nutrients
   g. Too rapid a flow will cause erosion
   h. Drainage canals must be provided to prevent ponding

3. a. D
   b. D
   c. D
   d. A
   e. A

4. a. A
   b. A
   c. D
   d. A
   e. D
   f. D
   g. D
   h. A
5. a. Nozzles
   b. Perforated pipe
   c. Rotating sprinkler heads
6. a, b, c
7. a. D
   b. A
   c. A
   d. D
   e. D
   f. A
8. b, c, e
9. a. D
   b. D
   c. A
   d. A
   e. A
   f. D
   g. A

10. a, d, f

11. Description should include one of the following:

    a) Overhead

        1) Water applied to surface of soil
        2) Hand-held hose
        3) Skinner system uses perforated pipe that produces a fine spray
        4) Soakers
        5) Trickle system uses plastic hoses to each pot
        6) Gates system uses small spray nozzle on perimeter of bench

    b) Subirrigation

        1) Water applied under surface of soil
        2) Tile line or perforated pipe located in bottom of watertight bench
        3) Watertight bench where pots are located is flooded
        4) Water moves upward into root zone by capillary action

12. Description should include:

    a) Flood irrigation

        1) Entire field is covered
        2) Used for horticultural crops that can tolerate excessive water

    b) Soaker irrigation

        1) Used in rolling land and closely growing crops
        2) Soakers provide a form of surface irrigation

13. Performance skill evaluated to satisfaction of instructor.

ORIENTATION TO LANDSCAPING
UNIT XV

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe landscaping terms, the areas to include, areas to be developed, and benefits of landscape planning. The student should also be able to develop a simplified landscape plan. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with orientation to landscaping to the correct definitions.
2. Identify nine landscape symbols.
3. Identify five construction symbols used in landscaping.
4. List four advantages of proper landscape planning.
5. Describe nine main areas to be included in a landscape plan.
6. Describe the three main areas to be developed in landscaping.
7. Match seven drawings to their uses.
8. Describe benefits for developing a landscape plan.
9. Describe the basic planting groups.
10. Develop simplified landscape plan.

ORIENTATION TO LANDSCAPING
UNIT XV

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheets.

  B. Provide students with information and assignment sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Give test.

II. Students:

  A. Read objectives.

  B. Study information sheets.

  C. Complete assignment sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1—Landscape Symbols

    2. TM 2—Construction Symbols

    3. TM 3—Main Areas in a Landscape Plan

    4. TM 4—Triangle

    5. TM 5—Compass

D. Assignment Sheet #1—Develop Simplified Landscape Plan

E. Test

F. Answer to test

II. REFERENCES:

A. Ingles, J. E. *Landscaping: Principles and Practices;* Albany, New York: Delman Publishers, 1978.

B. Nelson, W. R. *Landscaping Your Home;* Champaign: University of Illinois, 1977.

C. Conner, W. E. *Landscape Design;* San Luis Obispo: California Polytechnic State University, 1972.

ORIENTATION TO LANDSCAPING
UNIT XV

INFORMATION SHEET

I. Terms and definitions

A. Landscape—Area of land which the eye can comprehend in a single view, including all the objects seen

B. Landscape design—Art of arranging and fitting together of lands, plants, and buildings for human use and enjoyment

C. Landscape architect—Design engineer who uses plants and buildings materials

D. Landscape development—How to put the site, the plan, and the plants together

E. Foundation planting—Plants at the base of a building

F. Cultivar—Group of plants within a particular cultivated species that have distinguishing features

G. Public area—Area located from the street to the house, most prominent element being the house

H. Living area—Area located near the rear of the property; may include a patio, plantings, and sculptures

I. Service area—Area is usually located to the side or rear of the property

II. Landscape symbols (Transparency 1)

A. Conifer

B. Deciduous

C. Broadleaf evergreen

D. Palm

E. Small shrub

F. Multiple trunk

G. Flowing shrubs

H. Hedge

I. Ground covers

INFORMATION SHEET

III. Construction symbols (Transparency 2)

   A. Brick

   B. Decking

   C. Stonework

   D. Fencing

   E. Loose aggregates and mulches

IV. Advantages of proper landscape planning

   A. Utilizes land to the fullest

   B. Prevents costly mistakes

   C. Easier to test solution

   D. Makes more probable the realization of final goals

V. Items in a landscape plan

   A. Map—Through field survey

   B. Building—Indicate location of building and dimensions

   C. Minor structures—Existing walks, drives, patios, terraces, walls, and other minor structures

   D. Utilities—Both above ground and below ground

   E. Plant materials

      1. New and existing plants

      2. Location noted

      3. Indicate if to be saved

   F. House

      1. Floor plan

      2. Location on lot

   G. Soil

INFORMATION SHEET

1. Types
2. Problem areas

H. Drainage

1. Underground
2. Surface

I. Orientation

1. Position of sun
2. Prevailing wind direction

VI. Main areas to be developed (Transparency 3)

A. Public area

1. House most important
2. Blend structures with surroundings
3. Plantings and construction features provide proper setting

B. Living area

1. Both utility and beauty
2. Subspaces comfortable and convenient
3. Visually pleasing

C. Service area

1. Functional space
2. Space for service functions
3. Garbage cans and garden

VII. Drawing Instruments

A. T square—Used to draw parallel, horizontal, or vertical lines

B. Drawing pencil

1. Marking instrument
2. 2H or 3H leads

INFORMATION SHEET

C. Compass (Transparency 5)

  1. Creates circles

  2. Creates tree and shrub symbols

D. Protractor—Measures relationship between two lines

E. Triangle (Transparency 4)

  1. Used with a straightedge

  2. Common ones used: 30°-60°-90° and 45°-45°-90°

F. Scale—Measures in many scales

G. Erasers, eraser shields, drafting paper, pens—Needed to develop more efficient and neat drawings

VIII. Benefits for developing a landscape plan

A. Attractive grounds

B. Increase the value of land

C. Privacy for the family

D. Recreational needs of the family

E. Convenient, well-arranged, attractive service areas

F. Harmonize home buildings and various areas into one unit

IX. Basic planting groups

A. Corner planting

  1. Illustrate length to small buildings by planting out to the side of the corner

  2. Illustrate long building by planting in front of corners

  3. Tallest of the foundation plantings

B. Entrance planting

  1. Most attractive of front foundation plantings

  2. Draws eye toward entrance

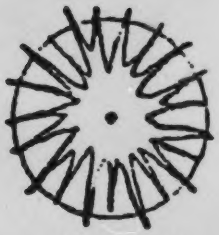
C. Base (foundation) planting

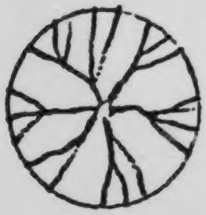
  1. Relates foundation of building to ground

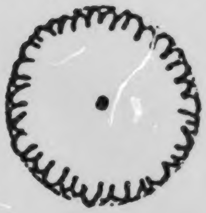
  2. Proportion to wall height

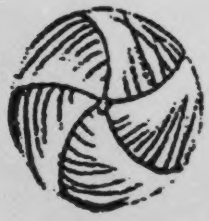
LANDSCAPE SYMBOLS

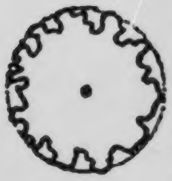
H-379-A

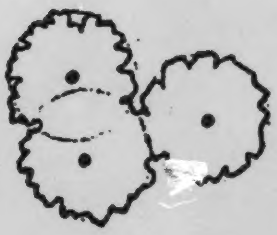

CONIFER

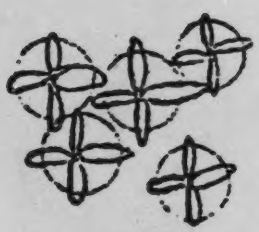

DECIDUOUS

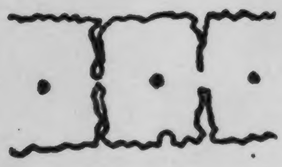

BROADLEAF EVERGREEN

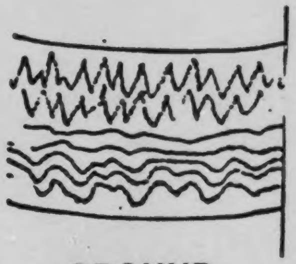

PALM


SMALL SHRUB


MULTIPLE TRUNK

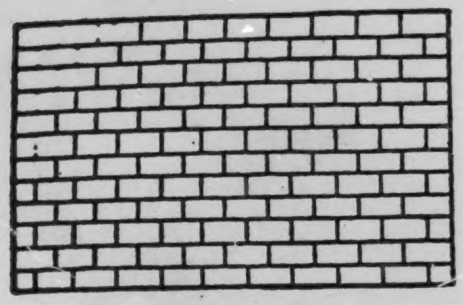

FLOWERING SHRUBS


HEDGE

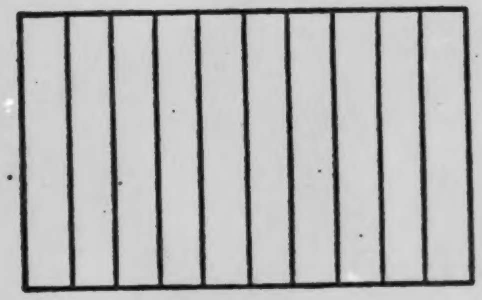

GROUND COVERS

TM 1

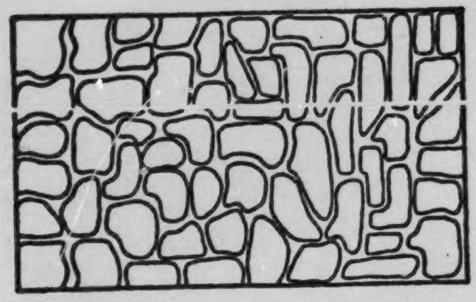
CONSTRUCTION SYMBOLS



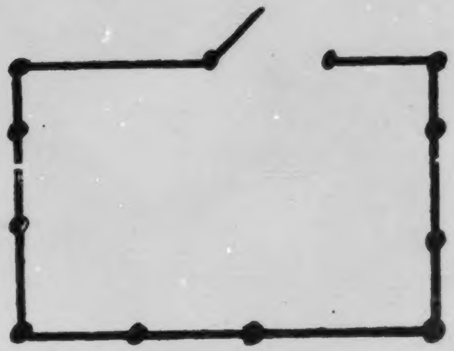
BRICK



DECKING



STONEWORK



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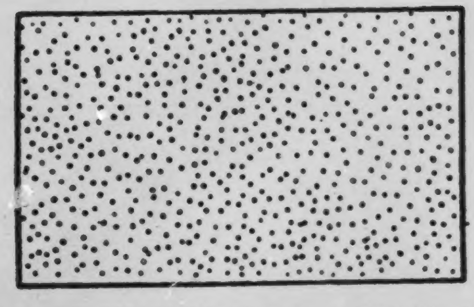
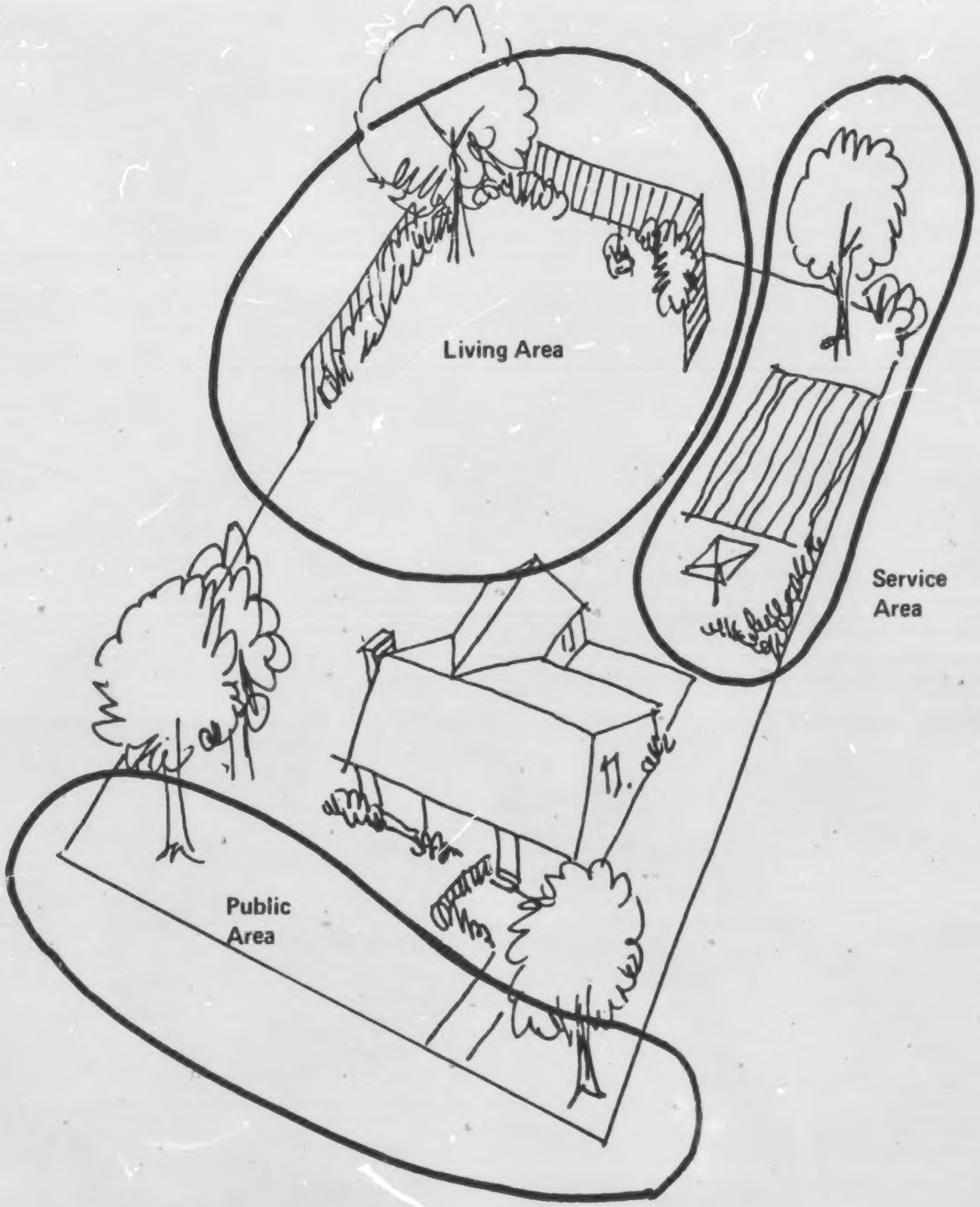


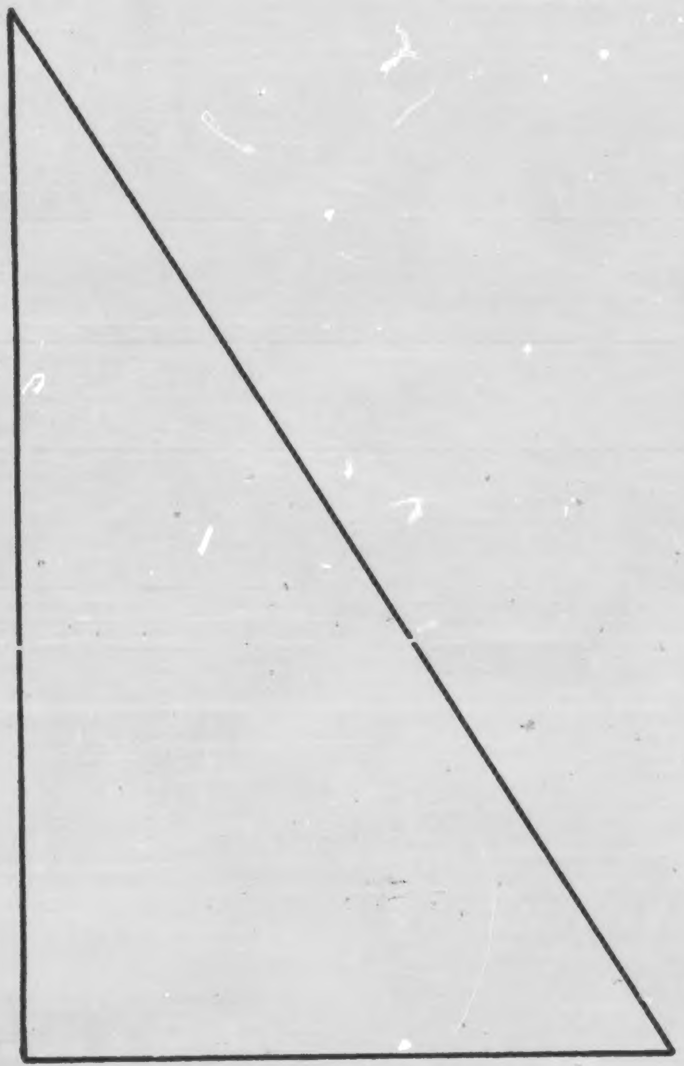
LOOSE AGGREGATES AND MULCHES (CRUSHED STONE, MARBLE CHIPS, WOOD CHIPS)

Main Areas in a Landscape Plan


Living Area
Service Area
Public Area

TM 3

TRIANGE



The 45 degree - 90 degree triangle

TM 4

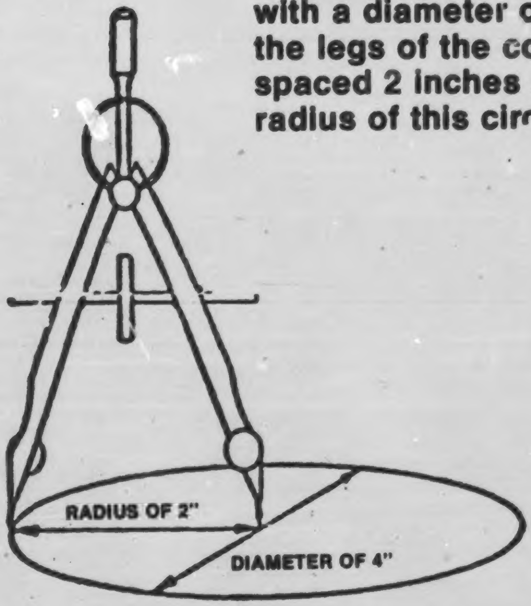

RADIUS OF 2"
DIAMETER OF 4"

Fig. 4-4 To create a circle with a diameter of 4 inches, the legs of the compass are spaced 2 inches apart. The radius of this circle measures 2 inches.

ORIENTATION TO LANDSCAPING
UNIT XV

ASSIGNMENT SHEET #1—DEVELOP SIMPLIFIED LANDSCAPE PLAN

1. Make a plan to scale of your home or an imaginary home
2. Make a site checklist
3. Use the principles and elements of design
4. Show the three basic areas
5. Indicate where you would put tall, low, horizontal, or vertical plantings
6. Present your plans to the class

ORIENTATION TO LANDSCAPING
UNIT XV
TEST

1. Match the terms on the right to the correct definitions.

____ a. Area usually located to the side or rear of the property

____ b. Area located from the street to the house, most prominent element being the house

____ c. Plants at the base of a building

____ d. Area of land which the eye can comprehend in a single view, including all the objects seen

____ e. Art of arranging and fitting together of lands, plants, and buildings for human use and enjoyment

____ f. Area located near the rear of the property; may include a patio, plantings, and sculptures

____ g. Group of plants within a particular cultivated species that have distinguishing features

____ h. How to put the site, the plan, and the plants together

____ i. Design engineer who uses plants and building materials

1. Foundation planting
2. Public area
3. Cultivar
4. Landscape architect
5. Landscape
6. Landscape development
7. Service area
8. Living area
9. Landscape design

2. Identify the following landscape by writing the correct numbers in the blank.

____ a. Conifer

____ b. Small shrubs

____ c. Deciduous

____ d. Broad leaf evergreen

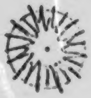
____ e. Palm

____ f. Ground cover

____ g. Multiple trunk

____ h. Flowering shrubs

____ i. Hedges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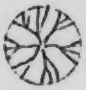
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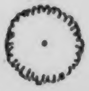
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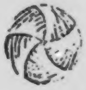
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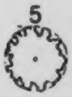
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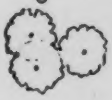
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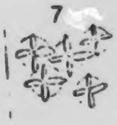
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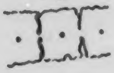
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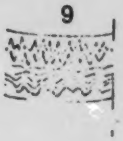

9

3. Identify the following construction symbols by writing the correct numbers in the blank.

____ a. Brick

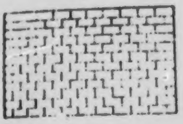
____ b. Decking

____ c. Stonework

____ d. Fencing

____ e. Loose aggregate and mulches

1



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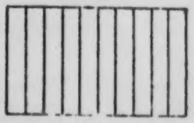

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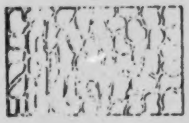

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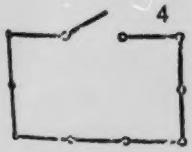

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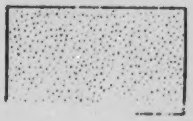


4. List four advantages of proper landscape planning.

a.

b.

c.

d.

5. Describe the nine items to be included in a landscape plan.

a. Map

b. Building

c. Minor structures

d. Utilities

e. Plant materials

f. House

g. Soil

h. Drainage

i. Orientation

6. Describe the three main areas to be developed in landscaping.

a. Public area

b. Living area

c. Service area

7. Match the seven drawing instruments on the right to their correct uses.

____ a. Creates circles; creates trees and shrubs symbols

____ b. Used to draw parallel, horizontal, or vertical lines

____ c. Used with a straightedge; common ones used: 30°-60°-90° and 45°;45°-90°

____ d. Measures relationship between two lines

____ e. Measures in many scales

____ f. Marking instrument; 2H or 3H leads

____ g. Needed to develop more efficient and neat drawings

1. T square
2. Drawing pencil
3. Compass
4. Protractor
5. Triangle
6. Scale
7. Erasers, eraser shields, drafting paper

8. Describe the benefits for developing a landscape plan.

9. Describe the basic planting groups listed below.

   a. Corner planting

   b. Entrance planting

   c. Base (foundation) planting

10. Develop a simplified landscape plan.

ORIENTATION TO LANDSCAPING
UNIT XV
ANSWERS TO TEST

1. a. 7
   b. 2
   c. 1
   d. 5
   e. 9
   f. 8
   g. 3
   h. 6
   i. 4

2. a. 1
   b. 5
   c. 2
   d. 3
   e. 4
   f. 9
   g. 6
   h. 7
   i. 8

3. a. 1
   b. 2
   c. 3
   d. 4
   e. 5

4. a. Utilizes land to the fullest

   b. Prevents costly mistakes

   c. Easier to test solution

   d. Makes more probable the realization of final goals

5. Description should include:

   a. Map—Thorough field study

   b. Building—Indicate location of building and dimension

   c. Minor structures—Existing walks, drives, patios, terraces, walls, and other minor structures

   d. Utilities—Both above ground and below ground

   e. Plant materials

      1) New and existing plants

      2) Location noted

      3) Indicate if to be saved

   f. House

      1) Floor plan

      2) Location on lot

- g. Soil
    - 1) Types
    - 2) Problem areas
- h. Drainage
    - 1) Surface
    - 2) Underground
- i. Orientation
    - 1) Position of sun
    - 2) Prevailing wind directions

6. Description should include:
    - a. Public area
        - 1) House most important
        - 2) Blend structures with surroundings
        - 3) Planting and construction features provide proper setting
    - b. Living area
        - 1) Both utility and beauty
        - 2) Subspaces comfortable and convenient
        - 3) Visually pleasing
    - c. Service area
        - 1) Functional space
        - 2) Space for service functions
        - 3) Garbage cans and garden

7. a. 3
    - b. 1
    - c. 5
    - d. 4
    - e. 6
    - f. 2
    - g. 7

8. Description should include:
   - a) Attractive grounds
   - b) Increase the value of land
   - c) Privacy for the family
   - d) Recreation needs of the family
   - e) Convenient, well-arranged, attractive service areas
   - f) Harmonize home buildings and various areas into one unit
9. Descriptions should include:
   - a) Corner planting
     - 1) Illustrate length to small buildings by planting out to the side of the corner
     - 2) Illustrate long buildings by planting in front of corners
     - 3) Tallest of the foundation plants
   - b) Entrance planting
     - 1) Most attractive of front foundation plantings
     - 2) Draws eye toward entrance
   - c) Base (foundation) planting
     - 1) Relates foundation of building to ground
     - 2) Proportion to wall height
10. Evaluated to satisfaction of instructor.

LANDSCAPE DESIGN
UNIT XVI

UNIT OBJECTIVE

After completion of this unit, the student should be able to demonstrate the knowiege of elements of landscape design, of drawing the plan, and how to select and avoid mistakes in foundation plantings. The student should also be able to state facts about entrance, corner, and foundation plantings and develop public, private, and service areas using landscape plants and structures. This knowledge will be evidenced by demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with landscape design to the correct definitions.
2. Distinguish between the characteristics of symmetrical and asymmetrical balance.
3. Select from a list true statements pertaining to landscape design sequence.
4. List three methods to attain contrast in landscape design.
5. Select from a list reasons for contrast in landscape design.
6. State the factors about landscape repetition.
7. List four factors about proportion or scale in landscape design.
8. Describe three types of landscape structures.
9. Demonstrate the ability to:
    a. Take measurements and prepare scaled drawing of landscape.
    b. Draw plants to scale.

LANDSCAPE DESIGN
UNIT XVI
SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information, assignment and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student:

  A. Read objectives.

  B. Study information sheets.

  C. Complete assignment sheets.

  D. Demonstrate ability to accomplish procedures outlined on job sheets.

  E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
  A. Objective sheet

  B. Information sheets

  C. Transparency masters

    1. TM 1—Balance: Symmetrical and Assymmetrical

    2. TM 2—Sequence

    3. TM 3—Contrast

    4. TM 4—Repetition

    5. TM 5—Scale and Proportion

    6. TM 6—Flagstone Paving Patterns

    7. TM 7—Brick Paving Patterns

- D. Assignment sheets #1—Draw Landscape Plan
- E. Job sheets
    1. Job Sheet #1—Take Measurements and Prepare Scaled Drawing of Landscape
    2. Job Sheet #2—Draw Plants to Scale
- F. Test
- G. Answers to test

II. References:

- A. Ingles, J. E. *Landscaping: Principles and Practices.* Albany, New York: Delmar Publishers, 1978.
- B. Nelson, W. R. *Landscaping Your Home.* Champaign: University of Illinois, 1977.
- C. Conner, W. E. *Landscape Design.* San Luis Obispo: California Polytechnic State University, 1972.

LANDSCAPE DESIGN
UNIT XVI

INFORMATION SHEET

I. Terms and definitions

A. Foundation planting—Plants at the base of a building

B. Landscape development—How to put the site, the plan, and the plants together

C. Hardiness—Plant's tolerance to temperature and climate

D. Subgrade—Prepared ground level upon which topsoil is placed for a lawn or garden

E. Shrub—Woody plant, smaller than a tree, and generally with multiple stems arising from the roots

F. Accent plant—Plant used singularly or in small groups for emphasis in the garden picture

G. Border planting—Flowers or shrubs planted around the edge of lawns or walks

H. Coniferous—Term applied to trees and shrubs which bear cones

I. Deciduous—Term applied to trees and shrubs having leaves which fall off during the dormant season

J. Ground cover—Plant or group of special value for covering the ground; may be used to prevent washing or erosion and to beautify

K. Hedge—Thicket of bushes, especially when planted as a fence or boundary

L. Ornamental—Plant used essentially for decorative purposes

M. Screening plant—Plants arranged so as to close off a view

N. Symmetrical—Same number of items on each side of a point

O. Asymmetrical—Uneven number of items on each side of a point

P. Proportion—Keeping all of the elements in relation to each other

Q. Repetition—Relate and tie two identical elements on a ratio basis

INFORMATION SHEET

II. Balance (Transparency 1)

- A. Symmetrical
    1. Visualized in a formal garden
    2. Focus on statue, body of water, or fountain
    3. Plants arranged the same on both sides
- B. Asymmetrical
    1. Varies mass, color, texture, and size
    2. Gives direction to planting
    3. Leads eye to a focal point
    4. Harmony with natural setting

III. Sequence in landscape design (Transparency 2)

- A. Change in form, color, texture or size
- B. Placements of plants
    1. Low plants—Foreground
    2. Medium plants—Midforeground
    3. Taller plants—Background
- C. Must know the growth rate

IV. Methods of attaining contrast in landscape design

- A. Use plants of different sizes, colors, and foliage characteristics
- B. Develop harmonious contrast

  Examples: Foliage, twig, bark
- C. Use alternative sources

  Examples: Fences, buildings, water pools, boulders

INFORMATION SHEET

V. Reasons for contrast in landscape design (Transparency 3)

   A. Breaks monotonous view

   B. Adds gradual and subtle form

   C. Colors few and far between

VI. Repetition (Transparency 4)

   A. Reappearance of same plant

   B. Varying and repeating shapes, colors, and textures

VII. Proportion or scale in landscape design (Transparency 5)

   A. Tie the design together

   B. Fit plant to your design

      1. Shapes and sizes

      2. Texture and colors

      3. Environmental conditions

VIII Major landscape structures

   A. Grading structures

      1. Retaining walls

         a. Retain earth

         b. Constructed of rock, stone, concrete

      2. Dry wall

         a. Without mortar

         b. Hold 6 to 10 foot high slope

         c. Made of large stone or concrete

      3. Drains and catch basins—Underground handling surface and subsurface run off water

INFORMATION SHEET

B. Circulation struction

  1. Drives

    a. Insure movement for vehicle use

    b. Double drive, 16 to 18 feet wide

  2. Walks

    a. Visual approach

    b. Physical access

    c. Five foot width

C. Surface structures (Transparency 6)

  .1 Brick

    a. Restful, harmonious effect

    b. Popular

  2. Flagstone

    a. Called "aristocrat" of landscape paving

    b. Orderly, regular paving pattern

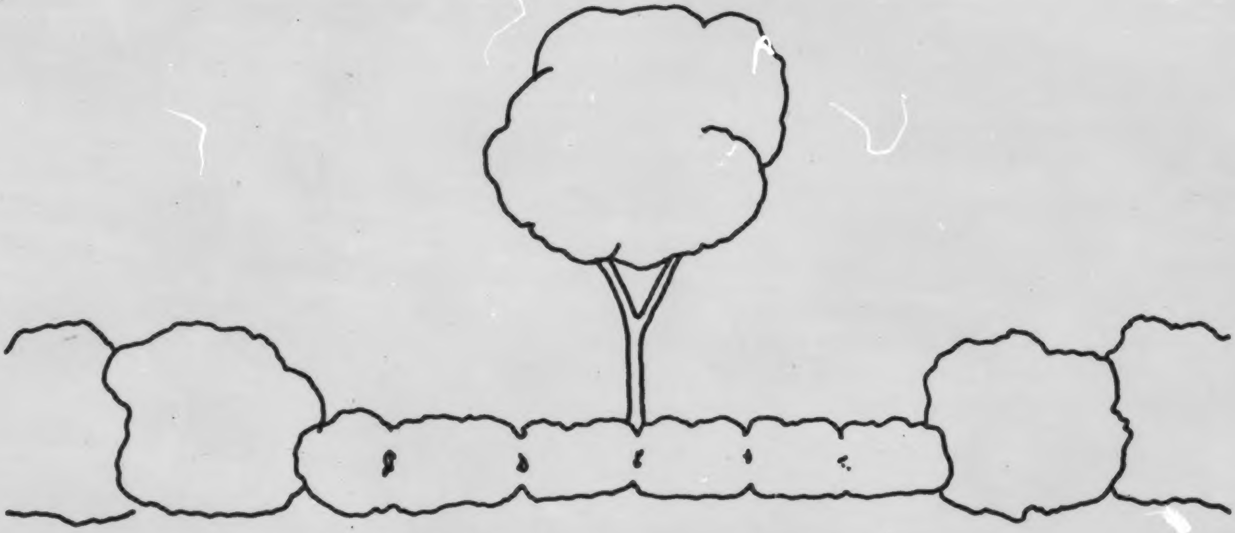
  3. Concrete

    a. Common

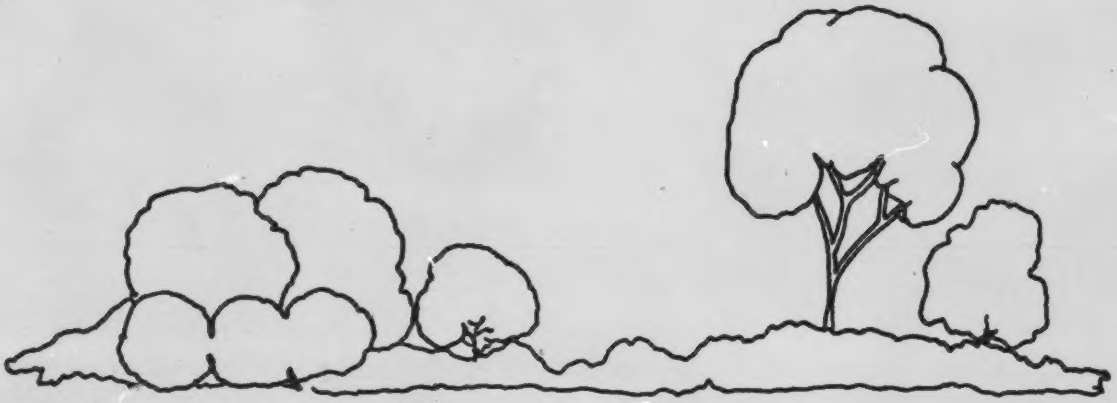
    b. Assumes any shape

    c. Many textures

BALANCE — SYMMETRICAL

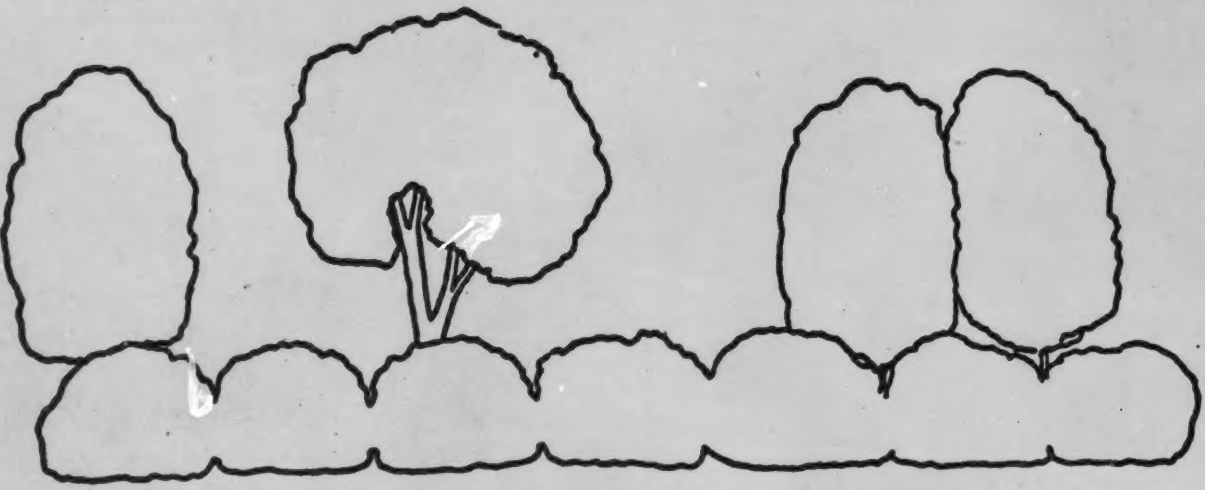


BALANCE — ASYMMETRICAL



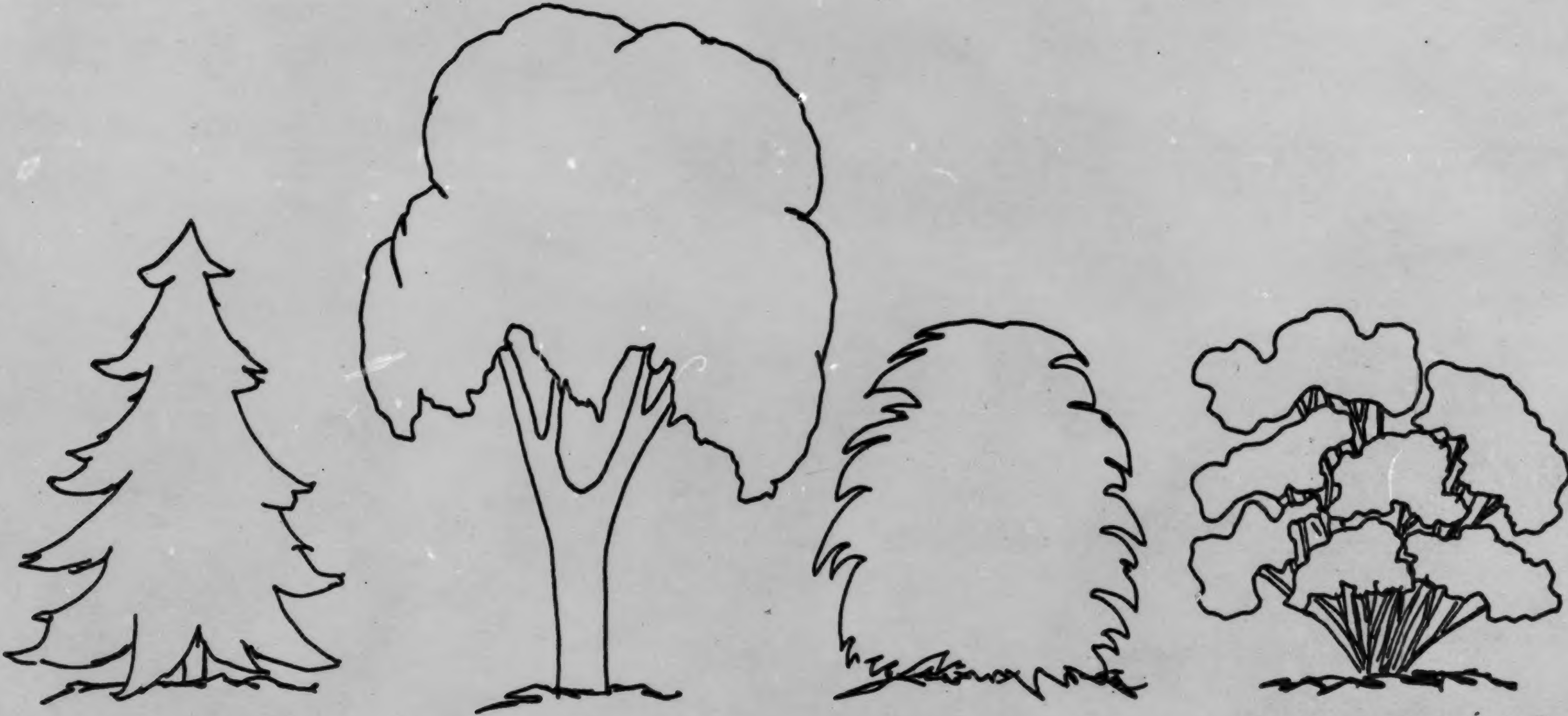
TM 1

SEQUENCE



TM 2

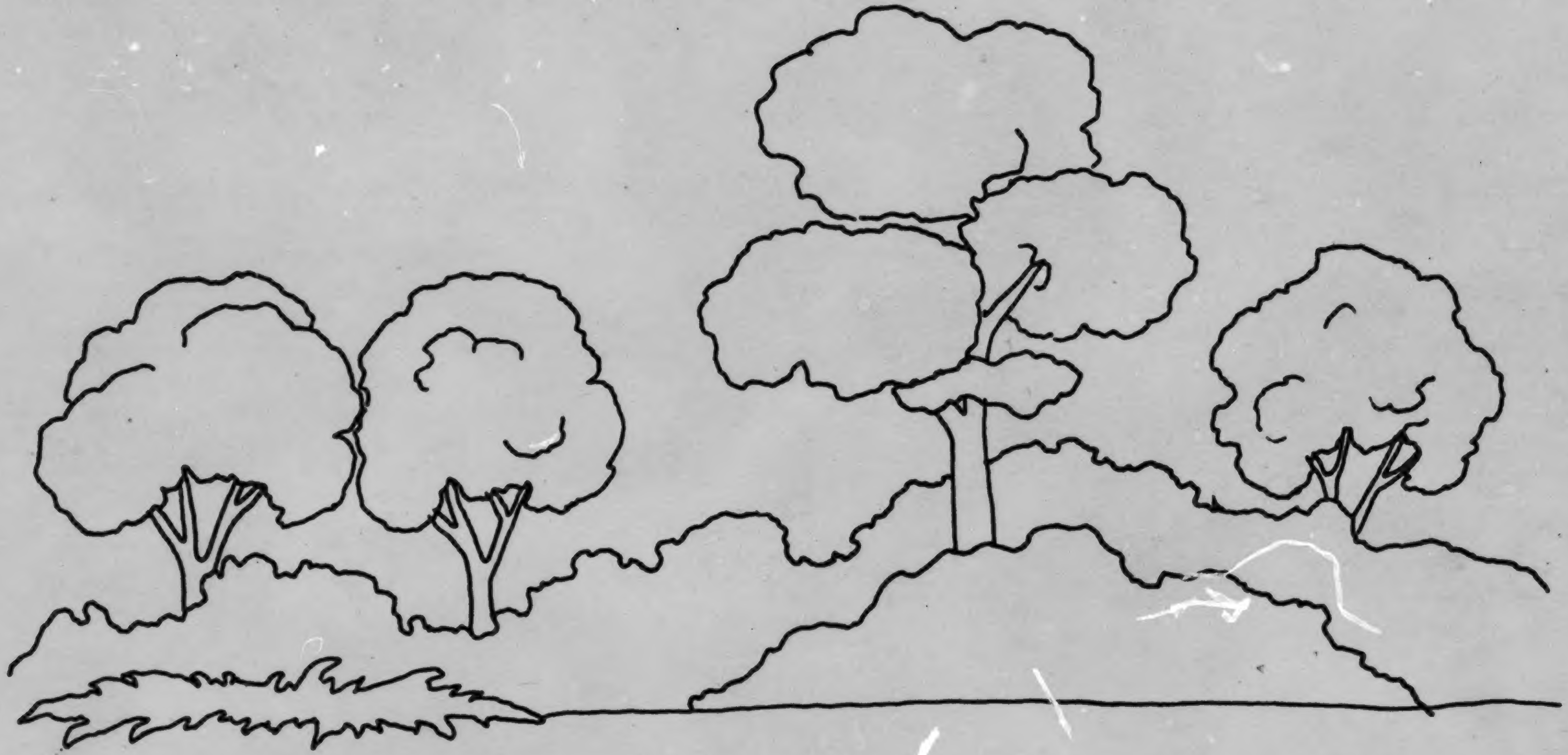
CONTRAST



TM 3

H-411-A

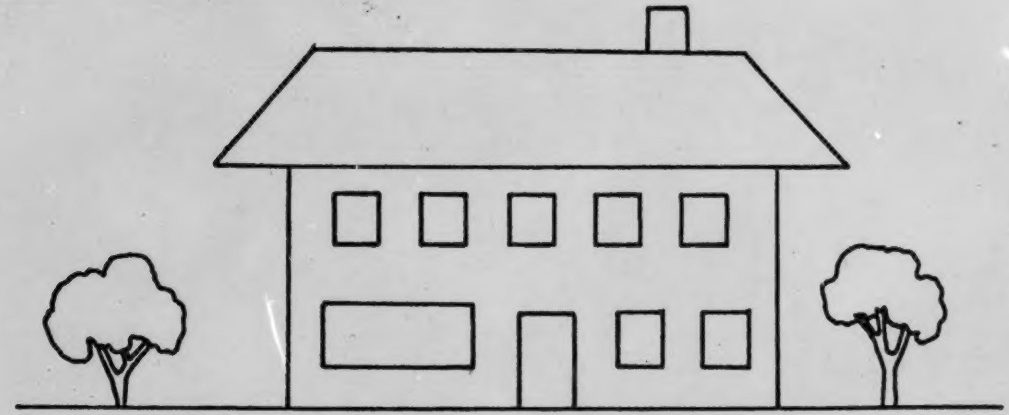
REPETITION



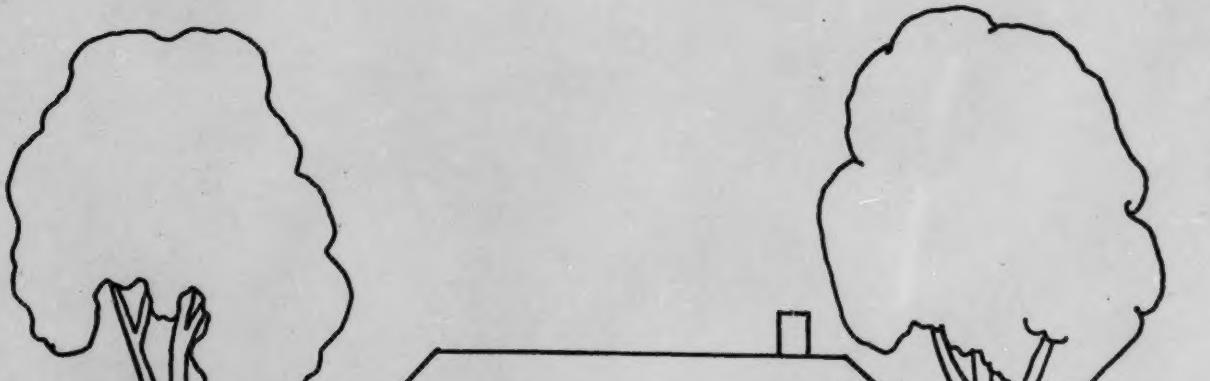
TM 4

H-413-A

SCALE AND PROPORTION

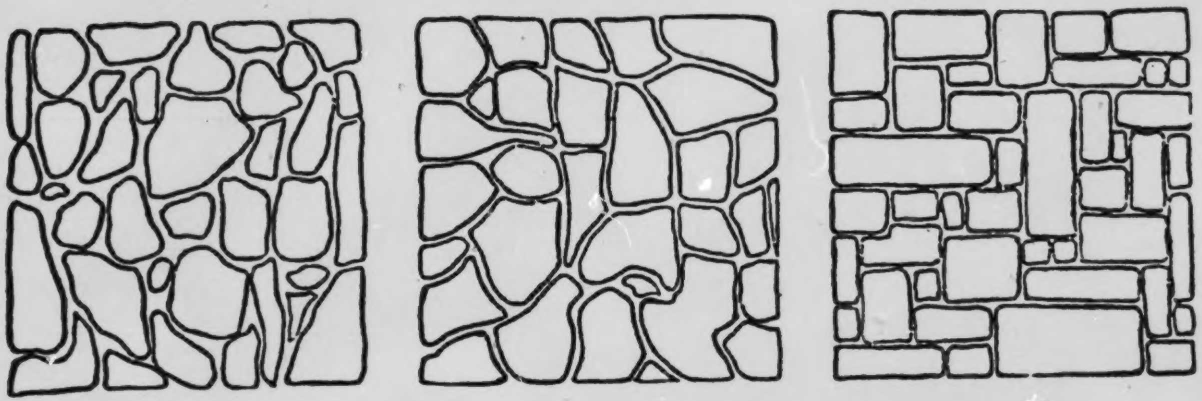


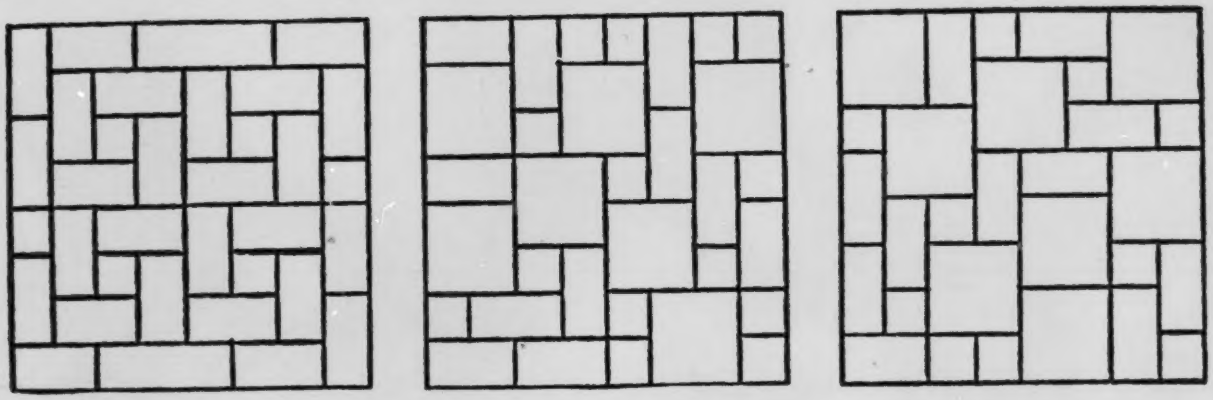
House overpowers landscape



Landscape overpowers house

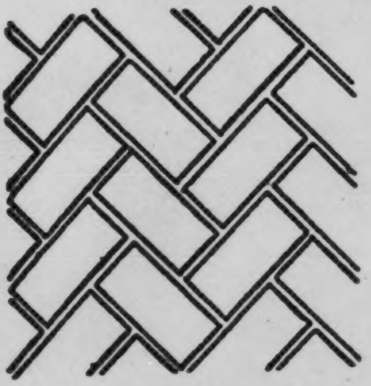
FLAGSTONE PAVING PATTERNS

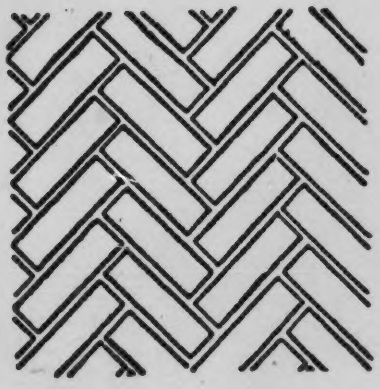


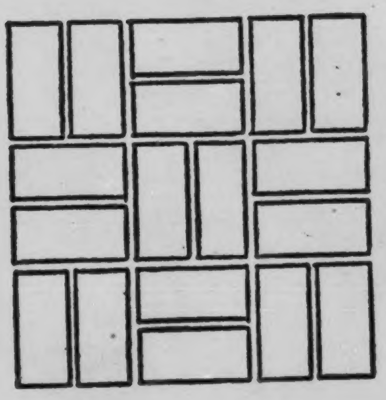


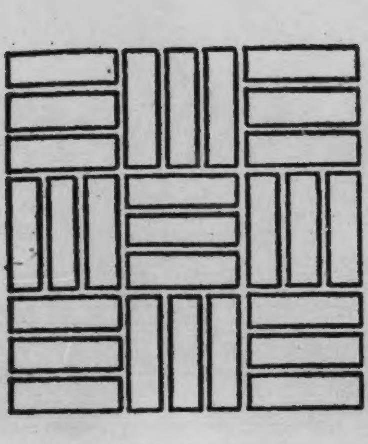
TM 6

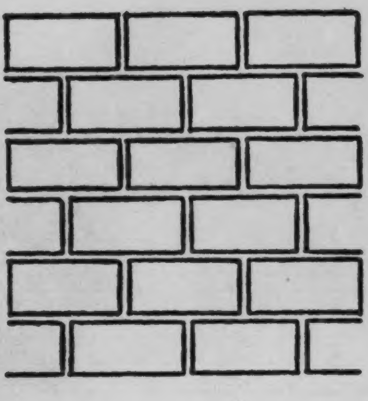
BRICK PAVING PATTERNS

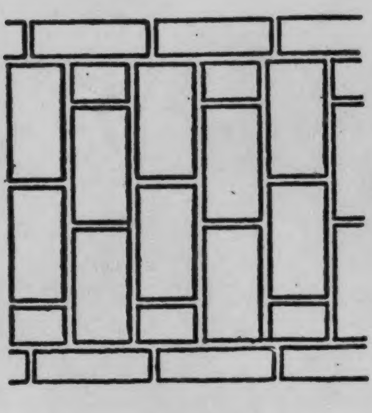








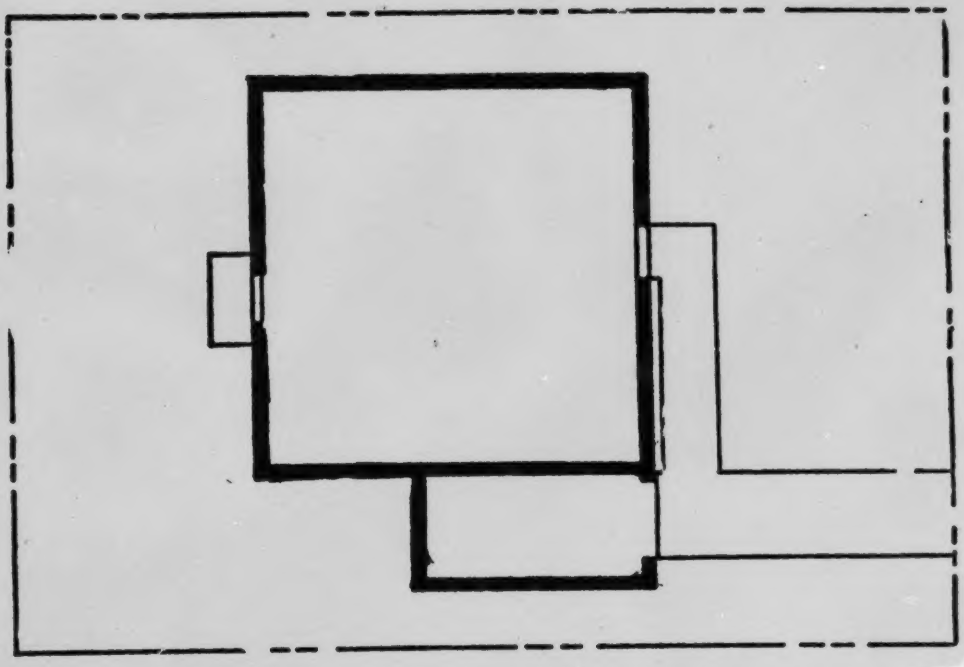




LANDSCAPE DESIGN
UNIT XVI

ASSIGNMENT SHEET #1—DRAW A LANDSCAPE PLAN

Using the basic symbols, draw a rough draft of a landscape plan showing the location of trees, shrubs, flower beds, and other features. Your plan should be attractive, interesting, convenient, and useful.



LANDSCAPE DESIGN
UNIT XVI

JOB SHEET #1—TAKE MEASUREMENTS AND PREPARE SCALE DRAWING OF LANDSCAPE

I. Equipment

   A. 100′ steel surveyor's tape

   B. ¼″ quadrille paper

   C. Architect's tracing paper

   D. 3-H pencil

   E. Notebook

II. Procedure

   A. Visit site of proposed landscape project

   B. Make notes on type of buildings, slope of land, driveways, curbs, water lines, and large trees

   C. Measure perimeter of property

   D. Sketch measurements of buildings, foundations, walks, drives, and other structures

   E. Note size of doors and windows in buildings and their locations

   F. Locate by measurement other features, such as water faucets, cellar entrances, and overhangs

   G. Note any other features that will affect the final design

   H. Prepare and initial ¼″ scaled drawing of the landscape

LANDSCAPE DESIGN
UNIT XVI

JOB SHEET #2—DRAW PLANTS TO SCALE

I. Equipment

  A. Drawing board

  B. T-square

  C. 45° triangle

  D. 12th scale

  E. Pencil, 3-H

  F. Graph paper

  G. ½'' roll of masking tape

II. Procedure

  A. Set architect's drawing page up on drawing board

  B. Review scale and measurements from notes

  C. Using 100' metal tape, measure the diameter of branch spread of five trees

  D. Draw on architect paper's the proper scaled drawing of these plants using ¼'' scale

  E. Label plants and proper measurements

LANDSCAPE DESIGN
UNIT XVI

TEST

1. Match terms on the right to the correct definitions.

____ a. Thicket of bushes, especially when planted as a fence or boundary

____ b. Plant or group of plants of special value for covering the ground; may be used to prevent washing or erosion and to beautify

____ c. Term applied to trees and shrubs having leaves which fall off during the dormant season

____ d. Woody plant, smaller than a tree, and generally with multiple stems arising from the roots

____ e. Plant used singly or in small groups for emphasis in the garden picture

____ f. Flowers or shrubs planted around the edge of lawns or walks

____ g. Prepared ground level upon which topsoil is placed for a lawn or garden

____ h. How to put the site, the plan, and the plants together

____ i. Plants at the base of a building

____ j. Relate and tie two identical elements on a ratio basis

____ k. Uneven number of items on each side of a point

____ l. Thicket of bushes, especially when planted as a fence or boundary

1. Deciduous
2. Ground cover
3. Border planting
4. Hedge
5. Landscape development
6. Subgrade
7. Accent plant
8. Shrub
9. Foundation planting
10. Hardiness
11. Coniferous
12. Asymmetrical
13. Ornamental
14. Screening plant
15. Symmetrical
16. Proportion
17. Repetition

____ m. Term applied to trees and shrubs which bear cones

____ n. Plant used singly or in small groups for emphasis in the garden picture

____ o. Plant's tolerance to temperature and climate

____ p. Plants used essentially for decorative purposes

____ q. Plants arranged so as to close off view

2. Distinguish between the characteristics of symmetrical (S) and asymmetrical (A) balance. Place the correct letter in the blanks provided.

____ a. Visualized in a formal setting

____ b. Varies mass, color, texture, and size

____ c. Focus on statue, body of water, or fountain

____ d. Gives direction to planting

____ e. Leads eye to a focal point

____ f. Harmony with natural setting

____ g. Plants arranged the same in both sides

3. Select from the following statements those that pertain to sequence in landscape design, by placing an x by the correct statements.

____ a. Refers to a logical order in the placement of plants based on their mature size and their rate of growth

____ b. A logical order or sequence would be placing low plants in the foreground, medium-sized plants in the mid-foreground, and taller plants in the background

____ c. Rate of plant growth should be known in order to have the proper sequence in the landscape

____ d. To know the cultivar is not important

4. List three methods of attaining contrast in landscape design.

   a.

   b.

   c.

5. Select the true statements below about attaining contrast in landscape design by placing an "X" by the true statement.

   ____ a. Breaks monotonous view

   ____ b. Adds gradual and subtle form

   ____ c. Colors few and far between

   ____ d. Foliage, twigs, and bark better and more harmonious if contrasted

6. State the factors about landscape design repetition.

   a.

   b.

7. List four factors about proportion or scale in landscape design.

   a.

   b.

   c.

   d.

8. Describe the three types of landscape structures.

   a. Grading structures

   b. Dry wall

   c. Drains and catch basins

9. Demonstrate the ability to:

   a. Take measurements and prepare scaled drawing of landscape.

   b. Draw plants to scale.

H-431-A

LANDSCAPE DESIGN
UNIT XVI

ANSWERS TO TEST

1. a. 4
   b. 2
   c. 1
   d. 8
   e. 7
   f. 3
   g. 6
   h. 5
   i. 9
   j. 17
   k. 12
   l. 11
   m. 16
   n. 10
   0. 13
   p. 14
   q. 15

2. a. S
   b. A
   c. S
   d. A
   e. A
   f. A
   g. S

3. b, c

4. a. Use plants of different sizes, colors, and foliage characteristics
   b. Develop harmonious contrast
   c. Use alternative sources

5. a, b, c

6. a. Reappearance of same plant
   b. Varying and repeating shapes, colors, and textures

7. a. Shapes and sizes
   b. Texture and colors
   c. Environmental condition
   d. Plant specifications

8. Description should include:
    a. Grading structures
        1) Retaining walls
            a) Retain earth
            b) Constructed of rock, stone, concrete
        2) Dry wall
            a) Without mortar
            b) Hold 6 to 10 foot slope
            c) Made of large stone or concrete
        3) Drains and catch basin
            a) Underground handling surface and subsurface runoff water
9. Performance skill evaluated to satisfaction of instructor.

PRUNING
UNIT XVII

UNIT OBJECTIVE

After completion of this unit, the student should be able to list facts concerning pruning, list the important aspects of plant maintenance, and name two methods of pruning. The student should also be able to demonstrate general rules of pruning and how to use pruning tools. This knowledge will be evidenced by demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with pruning with their definitions.
2. List five facts about pruning.
3. Select from a list purposes of pruning.
4. List two methods of pruning.
5. List six advantages of stem pruning.
6. List six advantages of root pruning.
7. Describe heading-back pruning.
8. Describe thinning-out pruning.
9. Describe five general rules for pruning.
10. Describe three pruning tools.
11. Demonstrate the ability to:
    a. Prune established evergreens.
    b. Top prune trees and shrubs.
    c. Prune established trees and shrubs.
    d. Prune new trees and shrubs.
    e. Trim hedges.
    f. Root prune trees and shrubs.

PRUNING
UNIT XVII

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheets.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheets.

   F. Demonstrate and discuss procedures outlines in job sheets.

   G. Give test.

II. Students:

   A. Read objectives.

   B. Study information sheets.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Include in this unit:

   A. Objective sheet

   B. Information sheets

   C. Transparency masters

      1. TM 1—Pruning Methods

D. Job Sheets

   1. Job sheet #1—Prune Established Evergreens
   2. Job Sheet #2—Top Prune Trees and Shrubs
   3. Job Sheet #3—Prune Established Trees
   4. Job Sheet #4—Prune New Trees and Shrubs
   5. Job Sheet #5—Trim Hedges
   6. Job Sheet #6—Root Prune Trees and Shrubs

E. Test

F. Answers to test

II. References: *Sunset Pruning Book* Menlo Park, California: Lane Magazine and Book Company, 1973.

PRUNING
UNIT XVII

INFORMATION SHEET

I. Terms and definitions

   A. Pruning—Removal of parts of the top or root systems of plants

   B. Fruit spurs—Stubby fruit-bearing twigs up to three inches long

   C. Twig—Very small branch of a tree

   D. Cane—Stem of various fruits, such as the raspberry or blackberry

   E. Shoot—Small outgrowth on a bush

   F. Lateral—Branches that are horizontal to the ground

   G. Crotch—Where two branches come together to form a "Y"

   H. Headed back—Terminal portion of twigs, canes, or shoots are removed

   I. Thinned out—Entire twig, cane, or shoot is removed

   J. Sucker—Shoots that emerge below the graft

   K. Espalier—Describing a tree or shrub trained to grow flat against a wall or along a fence, wire, or trellis

   L. Topiary—Describing trees or shrubs sheared to geometic shapes, such as pyramids, spheres, cones, and other shapes

   M. Hedge—Row of one kind of plant

   N. Pergola—Arbor or trelliswork of a structural nature, covered with vegetation

   O. Pollard—Tree from which the top is sheared so that is puts out a dense head of slender shoots

   P. Terminal bud—Secretes growth-inhibiting hormones which are translocated to lateral buds

   Q. Lateral bud—Located below terminal buds

INFORMATION SHEET

II. Facts about pruning
   - A. Has no specific season
   - B. Is a continuous process
   - C. Serves a purpose for the plant
   - D. Enhances the ornamental value of plants
   - E. Should prune with natural form of a plant, not against it

III. Purposes of pruning
   - A. Remove diseased, dead, or damaged limbs
   - B. Restrict or promote growth
   - C. Encourage or improve blooming
   - D. Develop certain forms of growth

IV. Methods of pruning
   - A. Pruning the stem
   - B. Pruning the root

V. Advantages of stem pruning
   - A. Reduce amount of growth
   - B. Influence vegetative-reproductive balance of plant
   - C. Reduce plant size, yield, and total amount of growth by removing healthy stems and leaves
   - D. Increase supply of essential elements to points of growth that remain
   - E. Promote making of cells and utilization of carbohydrates
   - F. Stimulate vegetative phase and retard reproductive phase

VI. Advantages of root pruning
   - A. Affect total amount of growth made
   - B. Influence vegetative-reproductive balance of the plant
   - C. Reduce amount of available essential elements and water
   - D. Promote root growth
   - E. Prepare plant for transplanting

INFORMATION SHEET

VII. Facts about heading-back pruning

   A. Terminal (top) portion of twigs, canes, or shoots are removed

   B. Stimulates the development of more points of growth

   C. Induces compact, dense, or branched type of growth

VIII. Facts about thinning-out pruning (Transparency 1)

   A. Entire twig, cane, or shoot is removed

   B. Does not prevent the development of lateral buds

   C. Induces open type of growth

IX. General rules for pruning

   A. Use only sharp and proper tools for the job

   B. Prune back to an existing bud (about ¼ inch above it) or to a side branch; NEVER LEAVE A STUB

   C. Cut larger limbs in three steps

      1. Make an undercut on the limb 9 to 12 inches from the main trunk, cutting into about ⅓ of the limb's diameter

      2. Go out an inch or two from the undercut and begin cutting into the top of the limb; as the saw cuts into the wood, the weight of the limb will cause a separation to take place between these two cuts, and the limb will fall

      3. Cut off the stump that remains flush with the main trunk; once the final cut is made, cover the cut area with tree paint

   D. Pruning in the summer months results in a greater dwarfing of trees than pruning in the late winter months

   E. Buy and plant trees and shrubs that have the characteristics, mature size, and shape you want

X. Pruning tools and how to use them

   A. Thumb and forefinger

      1. Pinch off any lanky shoots that may spoil the symmetry of perennials or shrubs

      2. Rub out any unwanted buds, long stems, and fruit spurs

      3. Snap off faded blooms or seed pods

INFORMATION SHEET

B. Edgers

  1. Enables user to stand up to cut the edges of lawns
  2. Cut the edges thick, spreading ground covers

C. Grass shears—Use only for shearing grass

D. Lopping shears

  1. Used wherever the added leverage of long handles will make an easier cut
  2. Used for reaching farther into a tree
  3. Used on small branches or twigs

E. Pruning shears

  1. Essential part of any gardener's tool kit
  2. Many uses:
     a. Small pruning jobs
     b. Bonsai pruning
     c. Flower shears
     d. Fruit shears

F. Hedge shears

  1. Hand-operated with various size handles
  2. Generally have one blade serrated and notched
  3. Notched blade holds bigger twig

G. Pruning saw

  1. Designed to cut quickly through fresh, green, wet wood
  2. Curved saws have teeth made to cut on the pull stroke; useful for overhead work
  3. Straight saws have teeth made to cut on the push stroke

INFORMATION SHEET

H. Pole pruners and pole saws

1. Used to cut or to saw branches high overhead

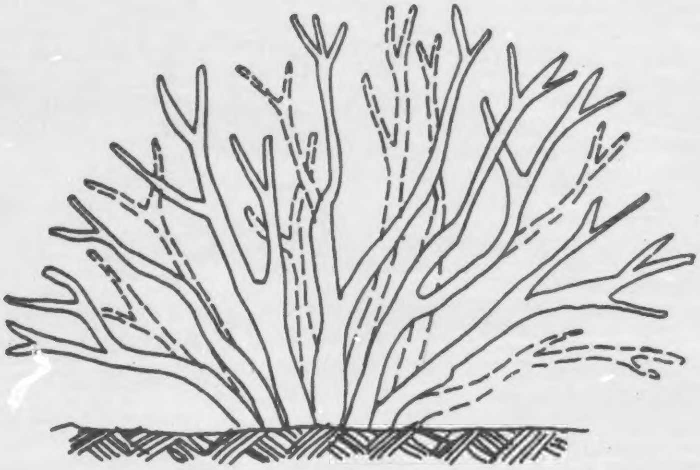
2. Telescoping, lightweight metal tube or wooden poles that lock together up to 18 feet long

(NOTE: FOR SAFETY'S SAKE, when using pole pruners or saws, avoid contact with electrical power lines!)

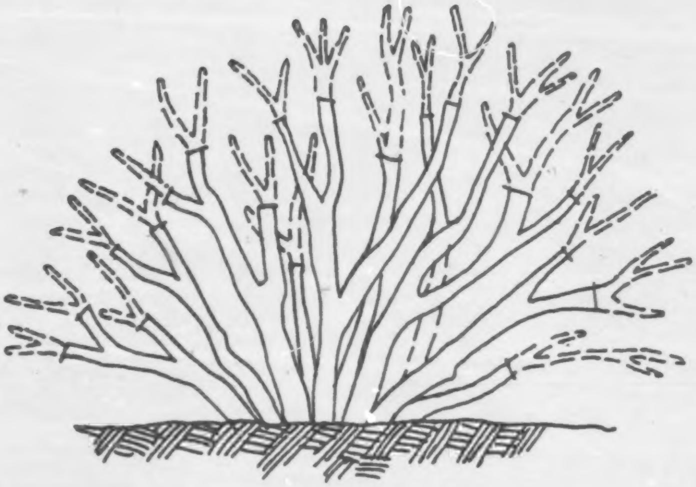
I. Chain saws—For pruning of large material

(NOTE: FOR SAFETY'S SAKE, never raise or lower a chain saw that is running or not cutting!)

Pruning Methods



Correct Method



Incorrect Method

TM 1

PRUNING
UNIT XVII

JOB SHEET #1—PRUNE ESTABLISHED EVERGREENS

I. Equipment

  A. Hedge shears

  B. Pruning loppers

  C. Pruning hand shears

  D. Hand pruning saw

  E. Tree paint

II. Procedure

  A. Head back terminal growth of coniferous evergreen

  B. Thin out dense center growth if needed

  C. Use hedge shears for evergreens that are shaped

  D. Inspect for insect or disease damage

  E. Clean up pruning debris

  F. Apply tree paint

PRUNING
UNIT XVII

JOB SHEET #2—TOP PRUNE TREES AND SHRUBS

I. Equipment

  A. Pruning saw

  B. Loppers

  C. Hand pruning shears

  D. Step ladder

  E. Tree paint

  F. Brush and strips of white plastic

II. Procedure

  A. Remove all sucker shoots first

  B. Observe tree from a distance to determine what must be trimmed, top or lower growth

  C. Prune out branches

  D. Paint fresh cuts with tree paint

  E. Stand back from tree; observe symmetry, balance, and natural shape of tree

  F. Clean and store tools

  G. Broom rake the area around the tree

PRUNING
UNIT XVII

JOB SHEET #3—PRUNE ESTABLISHED TREES

I. Equipment

- A. Pruning saw
- B. Loppers
- C. Hand shears
- D. Tree paint

II. Procedure

- A. Remove all damaged, diseased or insect-infested wood from tree
- B. Remove competing branches and dense growth from tree
- C. Prune lower branches that may be a hazard to passersby
- D. Shape the tree
- E. Coat all pruning cuts with tree paint
- F. Clean up the debris
- G. Clean equipment

PRUNING
UNIT XVII

JOB SHEET #4—PRUNE NEW TREES AND SHRUBS

I. Equipment

- A. Pruning saw
- B. Loppers
- C. Hand pruning shears
- D. Tree paint
- E. Clothespins

II. Procedure

- A. Determine the pruning cuts that should be made
- B. Use clothespins to identify limbs and major branches to be cut
- C. Remove small, heavy growth cuttings just above a bud
- D. Remove competing branches
- E. Shape tree by removing selected branches
- F. Coat cuts with tree paint
- G. Clean up debris

PRUNING
UNIT XVII

JOB SHEET #5—TRIM HEDGES

I. Equipment

   A. Trimming shears

   B. Grinder or hone stone

   C. Oil

II. Procedure

   A. Sharpen and oil triming shears

   B. Remove dead, diseased, or broken branches

   C. Eyeball the branches and decide which branches will be removed

   D. Shape hedge (narrow at the top then wider at the bottom) with sides sloping outward

   E. Clean, oil, and store equipment

   F. Clean up all clippings

PRUNING
UNIT XVII

JOB SHEET #6—ROOT PRUNE TREES AND SHRUBS

I. Equipment

A. Nursery-type pruning shears

B. Flat-edge shovel

C. Garden rake

II. Procedures

A. Rake away mulch around base of tree or shrub

B. Hold shovel vertically at a 90 degree angle to ground surface

C. Push down vertically into soil 14 to 16 inches but not beyond the edge of the outer branches

D. Continue to vertically cut in a series of connected cuts along a line circling the tree or shrub

E. Rake mulch around tree

F. Water tree if necessary

G. Clean and store tools

PRUNING
UNIT XVII

TEST

1. Match terms on the right to the correct defintions.

____ a. Stubby fruit bearing twigs up to three inches long

____ b. Shoots outgrowth on a bush

____ c. Terminal portion of twigs, canes or shocks are removed

____ d. Row of one kind of plant

____ e. Arbor or trilliswork of a structional

____ f. Located below terminal buds

____ g. Tree from which the top is sheared so that it puts out a dense head of slender shoots

____ h. Very small branch of a tree

____ i. Branches that are horizontal to the ground

____ j. Removal of parts of the top or root systems of plant

____ k. Describing a tree or shrub sheared to geometric shapes, such as pyramids, spheres, cones and other shapes

____ l. Entire twig, cane or shoot is removed

____ m. Where two branches come together to form a "Y"

____ n. Secretes growth inhibiting hormones, which are translocated to lateral buds

____ o. Entire twig, cane or shoot is removed

____ p. Describing a tree or shrub trained to grow flat against a wall or along a fence, wire or trellis

____ q. Stem of various fruits, such as the raspberry or blackberry

1. Pruning
2. Fruit spurs
3. Twig
4. Cane
5. Shoot
6. Lateral
7. Crotch
8. Headed back
9. Thinned out
10. Sucker
11. Espalier
12. Topiary
13. Hedge
14. Pergola
15. Pollard
16. Terminal bud
17. Laterial bud

2. List five facts about pruning.

   a.

   b.

   c.

   d.

   e.

3. Choose from the list below true statements about the purposes of pruning. Place an "X" by the true statements.

   ____ a. Remove disease, dead, or damaged limbs

   ____ b. Encourage or improve crop yield

   ____ c. Restrict or promote growth

   ____ d. Develop certain forms of growth

   ____ e. Develop good management

   ____ f. Encourage or improve blooming

4. List two methods of pruning.

   a.

   b.

5. List the advantages of stem pruning.

   a.

   b.

   c.

   d.

   e.

   f.

6. List the advantages of root pruning.

   a.

   b.

6. (con't) List the advantages of root pruning.

   c.

   d.

   e.

   f.

7. Describe heading-back pruning.

8. Describe thinning-out pruning.

9. Describe five general rules of pruning.

   a.

   b.

   c.

   d.

   e.

10. Describe three pruning tools.

    a. Looping shears

    b. Chain saw

    c. Hedge shear

11. Demonstrate the ability to:
    - a. Prune established evergreens.
    - b. Top prune trees and shrubs.
    - c. Prune established trees and shrubs.
    - d. Prune new trees and shrubs.
    - e. Trim hedges.
    - f. Root prune trees and shrubs.

PRUNING
UNIT XVII

ANSWERS TO TEST

1. a. 2
   b. 10
   c. 8
   d. 13
   e. 14
   f. 17
   g. 15
   h. 3
   i. 6
   j. 1
   k. 11
   l. 9
   m. 7
   n. 16
   o. 9
   p. 11
   q. 17

2. a. Has no specific season

   b. Is a continuous process

   c. Serves a purpose for the plant

   d. Enhances the ornamental value of plants

   e. Should prune with natural form of a plant, not against it

3. a, c, d, f

4. a. Pruning the stem

   b. Pruning the root

5. a. Reduce amount of growth

   b. Influence vegetative-reproductive balance of plant

   c. Reduce plant size, yield, and total amount of growth by removing healthy stems and leaves

   d. Increase supply of essential elements to points of growth that remain

   e. Promote making of cells and utilization of carbohydrates

   f. Stimulate vegetative phase and retard productive phase

6. a. Affect total amount of growth made

   b. Influence vegetative-reproductive balance of the plant

   c. Reduce amount of available essential elements and water

   d. Promote root growth

   e. Favor reproduction and retard vegetative phases of plant

   f. Prepare plant for transplanting

7. Description should include:
    a. Terminal (top) portion of twigs, canes, or shoots are removed
    b. Stimulates the development of more points of growth
    c. Induces compact, dense, or branched type of growth
8. Description should include:
    a. Entire twig, cane, or shoot is removed
    b. Does not prevent the development of lateral buds
    c. Induces open type of growth
9. Description should include:
    a) Use only sharp and proper tools for the job
    b) Prune back to an existing bud (about ¼ inch above it) or to a side branch; NEVER LEAVE A STUB
    c) Cut larger limbs in three steps
        1) Make an undercut on the limb 9 to 12 inches from the main trunk, cutting into about 1/3 of the limb's diameter
        2) Go out about an inch or two from the undercut and begin cutting into the top of the limb; as the saw cuts into the wood, the weight of the limb will cause a separation to take place between these two cuts, and the limb will fall
        3) Cut off the stump that remains flush with the main trunk; once the final cut is made, cover the cut area with tree paint
    d) Pruning in the summer months results in a greater dwarfing of trees than pruning in the late winter months
    e) Buy and plant trees and shrubs that have the characteristics, mature size, and shape you want
10. Description should include:
    a. Lopping shears
        1) Used wherever the added leverage of long handles will make an easier cut
        2) Used for reaching farther into a tree
        3) Used on small branches or twigs

10. (con't)

    b. Chain saws—for pruning of large material

    c. Hedge shears

        1) Hand-operated with various size handles

        2) Generally have one blade serrated and notched

        3) Notched blade holds bigger twig

11. Performance skills evaluated to satisfaction of instructor.

TRANSPLANTING SEEDLINGS
UNIT XVIII

UNIT OBJECTIVES

After completion of this unit, the student should be able to demonstrate the procedures to follow before and after transplanting during the actual transplanting process. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with transplanting seedlings.
2. Select from a list statements that are true about the care of seedlings before transplanting.
3. Distinguish between the characteristics of plastic pots, clay pots, plant bands, and peat pots.
4. List three factors to consider when selecting plant containers.
5. Select from a list rules to follow when transplanting seedlings.
6. List three steps in the process by which plants are hardened.
7. Demonstrate the ability to:
    a. Transplant seedlings from seed flats to individual containers.
    b. Transplant annuals.
    c. Wrap trees.
    d. Transplant trees and shrubs.
    e. Plant balled and burlap stock.
    f. Ball and burlap trees and shrubs.

TRANSPLANTING SEEDLINGS
UNIT XVIII

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Discuss unit and specific objectives.
- D. Discuss information sheets.
- E. Demonstrate and discuss procedures outlined in the job sheets.
- F. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheets.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
- C. Job sheets
    1. Job Sheet #1—Transplant Seedlings from Seed Flats to Individual Containers

2. Job Sheet #2—Transplant Annuals
3. Job Sheet #3—Wrap Trees
4. Job Sheet #4—Transplant Trees and Shrubs
5. Job Sheet #5—Plant Balled and Burlap Stock
6. Job Sheet #6—Ball and Burlap Trees and Shrubs

E. Test

F. Answers to test

II. References:

A. Hartman, H. T., and Kester, P. E. *Plant Propagation: Principles and Practices.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1974.

B. *Garden Seed Product Information Manual.* Downers Grove, Illinois: Vaughn's Seed Company. 1974.

TRANSPLANTING SEEDLINGS
UNIT XVIII
INFORMATION SHEET

I. Terms and definitions

   A. Hardening—Placing plants in harsher environments for lengthening periods of time to prepare them for planting outside

   B. Transpiration—Loss of water vapor from the plant through the leaves

II. Care of seedlings before transplanting

   A. Watering

      1. Amount of water applied each day depends on sunlight and temperature,

         a. Less water is needed on cool, cloudy days

         b. More water is needed on hot, sunny days

      2. Apply enough water to keep the soil moist until just before sundown

   B. Temperature

      1. Cool season plants

         Examples: Cabbage, snapdragons

         a. Night temperatures: 50-55°F

         b. Day temperatures: 60-70°F

      2. Warm season plants

         Examples: Tomatoes, marigolds, petunia

         a. Night temperatures: 55-60°F

         b. Day temperatures: 70°F

      3. Temperature should be kept constant

   C. Light

      1. Amount depends on kind of plant being grown

      2. Too much light will burn and damage foliage

      3. Too little light will cause the plant to have a tall, thin stem

INFORMATION SHEET

D. Disease control—Use sterile soil for seeding

III. Types of pots available for transplanting

A. Plastic pots

1. Need ⅓ less water than other types
2. Fertilizer stays in the soil, won't seep through the pot

B. Clay pots

1. Require more water
2. Provide better aeration of roots
3. May allow growth of fungus

C. Plant bands

1. Made of wood or tar paper
2. Require more water
3. Provide good root aeration
4. Will not withstand much handling

D. Peat pots

1. Made of 75% peat and 25% wood fiber
2. Require more water
3. Provide good root aeration
4. Should not be removed when seedlings are transplanted outdoors

IV. Factors to consider when selecting plant containers

A. Cost of container

B. Strength of container

C. Absorption qualities

INFORMATION SHEET

(NOTE: Clay, peat, and wooden containers absorb nitrogen. Extra nitrogen fertilizer must be used with these pots.)

D. Appearance of plant in container

E. Customer acceptance

V. Rules to follow when transplanting seedlings

A. Transplant when true leaves appear

B. Keep newly transplanted seedlings shaded

C. Keep newly transplanted seedlings in cooler temperatures

D. Water with a fine mist to prevent washing of the soil

E. Fertilize once a week (2 tablespoons of 20-20-20 per 2 gallons of water)

VI. Hardening plants for transplanting outside

A. Slowly reduce the amount of water for one to two weeks

B. Slowly reduce the temperature around the plant to the outdoor temperature for one to two weeks

C. Move plants outdoors

TRANSPLANTING SEEDLINGS
UNIT XVIII

JOB SHEET #1
TRANSPLANT SEEDLINGS FROM SEED FLATS TO INDIVIDUAL CONTAINERS

I. Equipment

A. One flat of seedlings

B. Sterile soil

C. Soilable containers

II. Procedure

A. Fill the container to within ½ inch of the top; level the surface

B. Poke holes in the soil large enough for the root system of plants

C. Carefully lift seedlings by the leaves from germinating soil

NOTE: DO NOT transplant weak, damaged, or deformed seedlings.)

D. Place the roots and stems in the holes and press the soil firmly around the root system

(NOTE: All leaves and a portion of the stem should be above the soil.)

E. Thoroughly water the soil with a fine mist

F. Place the transplanted seedlings in a shaded area

G. Keep the temperature about 10° cooler than before transplanting

H. Keep the soil moist for a few days

TRANSPLANTING SEEDLINGS
UNIT XVIII

JOB SHEET #2—TRANSPLANT ANNUALS

I. Equipment

   A. Garden spade

   B. Hand trowel

   C. Wood stakes

   D. Lime

   E. Soil soaker

   F. Annual to be transplanted

   G. Starter solution

   H. Water

   I. Compost material

II. Procedure

   A. Water thoroughly at least 2 hours before transplanting

   B. Prepare annual bed by deep spading

   C. Mix in compost material and light dressing of 5-10-5 common fertilizer

   D. Determine arrangement desired

   E. Check color harmony

   F. Stake out guides for planting

   G. Firm soil around the root

   H. Water the bed

   I. Clean tools

TRANSPLANTING SEEDLINGS
UNIT XVIII

JOB SHEET #3—WRAP TREES

I. Equipment

- A. Kraft crepe paper, 6' wide
- B. Twine

II. Procedure

- A. Choose tree needed to be wrapped
- B. Remove all suckers from trunk
- C. Wrap spirally around the lower part of bottom branch down the trunk to the ground
- D. Overlap each wrap ½ of preceding wrapping
- E. Secure final wrap near the ground with twine
- F. Wrap twine spirals up the trunk and secure it by tying above the lower branches

TRANSPLANTING SEEDLINGS
UNIT XVIII

JOB SHEET #4—TRANSPLANT TREES AND SHRUBS

I. Equipment

  A. Nursery spade

  B. Water hose

  C. Water can

II. Procedure

  A. Keep seedlings shaded and roots moist

  B. Pack with sphagnum to keep roots moist

  C. Plant at the same level as they are growing in the flat

  D. Prune off broken roots or damaged top growth

  E. Spread roots out and firm soil around them

  F. Fill trench with soil up to about ½ the depth

  G. Water soil around seedlings

  H. Finish filling the hole to surface level

  I. Firm soil with shoe

TRANSPLANTING SEEDLINGS
UNIT XVIII

JOB SHEET #5—PLANT BALLED AND BURLAP STOCK

I. Equipment

- A. Round tipped shovel
- B. Tamping tool
- C. Topsoil
- D. Water

II. Procedure

- A. Select the balled and burlap plant
- B. Select the location
- C. Dig a hole 4′ wider and deeper than ball on plant
- D. Set balled and burlap plant in hole
- E. Turn plant so that best side of plant is facing where it will be seen the most
- F. Place 3 to 4′ of topsoil around ball of plant
- G. Tamp soil
- H. Add another 3 to 4′ of soil
- I. Continue until hole is filled
- J. Loosen burlap around ball and roll back to soil
- K. Fill hole with water
- L. Fill hole with topsoil, leaving at least 2′ depression around the plant to catch water

TRANSPLANTING SEEDLINGS
UNIT XVIII

JOB SHEET #6—BALL AND BURLAP TREES AND SHRUBS

I. Equipment

   A. Long or short handled shovel

   B. Roll of 48" burlap

   C. Heavy sisal twine

   D. Pocket knife

II. Procedure

   A. Dig completely around tree a trench at least 6' wide and 14' deep

   B. Spread burlap on ground near tree

   C. Dig under ball of soil

   D. Place on spread burlap

   E. Prune away ragged roots

   F. Shape into a ball

   G. Pick up opposite diagonal corners of burlap and tie corners around truck

   H. Water balled tree or shrub with a fine mist of water

   I. Clean tools

TRANSPLANTING SEEDLINGS
UNIT XVIII

TEST

1. Define the following terms associated with transplanting seedlings.

   a. Transpiration—

   b. Hardening—

2. Select from the list below true statements about care of seedlings before transplanting. Place an "X" in the correct blanks.

   ____ a. Amount of water applied each day depends on size of plant and container

   ____ b. Cool season plants should be kept at 60-70°F in the daytime and at 50-55° at night

   ____ c. Less water is needed by plants on hot, sunny days

   ____ d. Providing light will cause the plant to have a short, thickened stem

   ____ e. Warm-season plants need a nighttime temperature of 50-55°F and a daytime temperature of 60-70°F

   ____ f. Disease can be controlled by using sterile soil for seeding

   ____ g. Apply enough water to keep the soil moist until just before sundown

   ____ h. Too little light will cause seedlings to have a tall, thin stem

   ____ i. Less water is needed on cool, cloudy days

   ____ j. Newly transplanted seedlings should be kept at variable temperatures

3. Distinguish between the characteristics of plastic pots (PL), clay pots (C), plant bands (PB), and peatpots (PE) by placing the correct letters in the blanks next to the statements that identify the characteristics of each.

(NOTE: Some statements may be true of more than one container.)

___ a. Provide good aration to plant roots

___ b. Require more water

___ c. May allow the growth of fungus

___ d. Need 1/3 less water than other types

___ e. Will not withstand much handling

___ f. Should not be removed when seedlings are transplanted outdoors

___ g. Fertilizer stays in the soil, won't seep through the pot

___ h. Made of 75% and 25% wood fiber

___ i. Made of wood or tar paper

4. List three factors to consider when selecting plant containers.

a.

b.

c.

5. Select from the following list rules to follow when transplanting seedlings. Place an "X" in the correct blanks.

___ a. Fertilize once a week (2 tablespoons of 20-20-20 per 2 gallons of water)

___ b. Water with a fine mist to prevent washing of the soil

___ c. Keep newly transplanted seedlings shaded

___ d. Fertilize once a week (1 tablespoon of 5-10-5 per 5 gallons of water)

___ e. Keep newly transplanted seedlings in cooler temperatures

___ f. Transplant when true leaves appear

6. List three steps in the process by which plants are hardened.

   a.

   b.

   c.

7. Demonstrate the ability to:

   a. Transplant seedlings from seed flats to individual containers.

   b. Transplant annuals.

   c. Wrap trees.

   d. Transplant trees and shrubs.

   e. Plant balled and burlap stock.

   f. Ball and burlap trees and shrubs.

TRANSPLANTING SEEDLING
UNIT XVIII
ANSWERS TO TEST

1. a. Transpiration—Loss of water vapor from the plant through the leaves

   b. Hardening—Placing plants in harsher environments for lengthening periods of time to prepare them for planting outside

2. b, f, g, h, i

3. a. C, PB, PE

   b. C, PB, PE

   c. C

   d. PL

   e. PB

   f. PE

   g. PL

   h. PE

   i. PB

4. Any three of the following:

   a. Cost of container

   b. Strength of container

   c. Absorption qualities

   d. Appearance of plant in container

   e. Customer acceptance

5. a, b, c, e, f

6. a. Slowly reduce the amount of water for one to two weeks

   b. Slowly reduce temperature around plant to the outdoor temperature for one to two weeks

   c. Move plants outdoors

7. Performance skills evaluated to satisfaction of instructor.

FUNDAMENTALS OF ELECTRICITY
UNIT I

UNIT OBJECTIVE

After completion of Unit I, the student should be able to define common electrical terms that are necessary in understanding the behavior of electricity and the rules that it follows. The student should be able to calculate the cost of electricity and distinguish between a 115-volt and a 230-volt circuit. The student should be able to identify various means by which electricity is transported from generator to the rural area. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define ten terms associated with electricity.
2. Name six benefits derived from the use of electricity.
3. Discuss the electron theory.
4. Name the two sources of rural electricity.
5. Name the four means of transporting electricity.
6. Distinguish between a 115-volt service and a 230-volt service.
7. Name the two types of power suppliers.
8. Name the power supplier that services his area.
9. Define Ohm's law as related to electricity.
10. Name the three types of electrical rates.
11. List the two types of kilowatt-hour electric meters.
12. Read an electrical meter and calculate the kilowatt-hours using the residential rate.
13. Calculate the kilowatt-hours for operating an electrical motor for a given number of hours.
14. Calculate problems determining volts, watts, and amps.

FUNDAMENTALS OF ELECTRICITY
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets with students.

   F. Give test.

II. Students:

   A. Read objective sheet.

   B. Study information sheets.

   C. Work assignment sheets and turn in to instructor.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheets

   C. Transparency masters

      1. TM 1--Electrical Transporting Lines

      2. TM 2-3--Ohm's Law

      3. TM 4--Pointer-Dial Electric Meter

        4. TM 5--Cyclometer Electric Meter

    D. Assignment sheets

        1. Assignment Sheet #1--Calculate Cost of Operating Electrical Equipment

        2. Assignment Sheet #2--Calculate Volts, Watts, and Amps

        3. Assignment Sheet #3--Calculate Residential Electric Rates

    E. Test

    F. Answers to test

II. References:

    A. Brown, Robert H. Farm Electrification. New York: McGraw-Hill Book Company, Inc.

    B. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. Farm Mechanics Text and Handbook. Danville, Illinois: The Interstate Printers and Publishers, Inc.

    C. Farm Electricity. State of Tennessee, Department of Education, Division of Vocational Education.

    D. Basic Electricity and Practical Wiring Lessons. The Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

    E. Understanding Electricity and Electrical Terms. American Association for Vocational Instructional Materials, Athens, Georgia, 1974. (Order from Agricultural Engineering Department, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, NE 68583.)

FUNDAMENTALS OF ELECTRICITY
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Electricity--A source of energy that can be easily converted into light, heat, or power

   B. Ampere (Amp)--A unit of measure of the rate of flow of electricity through a wire

   C. Volt--A unit of measure of electrical pressure

   D. Watt--A unit of measure used in determining the rate of energy supplied

   E. Watt-hour--One watt for one hour

   F. Kilowatt (KW)--1,000 watts

   G. Kilowatt-hour--The reference indicating the use of 1,000 watts of electricity for one hour

   H. Horsepower (hp)--A unit of mechanical power which is equal to 746 watts of electrical power

   I. Direct current (DC)--The term meaning that the current flows in one direction at a continuous rate

   J. Alternating current (AC)--The term meaning that the current reverses at regular intervals

   K. Circuit--A complete path through which electricity flows, such as from the power source to a lamp, through the lamp, and back to the power source

   L. Switch--A device used to open or close a circuit

   M. Fuse--A safety device which burns out when the current becomes too great

      (NOTE: A fuse must be replaced when blown.)

   N. Circuit breaker--A safety device which opens the circuit by tripping a switch rather than burning

      (NOTE: A circuit breaker can be reset after time allowed for cooling.)

INFORMATION SHEET

O. Conductors--The wires which carry the electricity

P. Insulation--A protective covering over wires to prevent completing a circuit except where desired

Q. Hot wires--The current carrying conductors with electrical pressure on them (usually black or red), connected to fuse or circuit breaker at distribution panel

R. Neutral wires--The current carrying conductors with no pressure on them (usually white), connected to neutral base at the distribution panel

S. Grounding--The safety requirement of the electrical code which reduces the possibility of electrical shock, fires, and damage to appliances and motors. Grounding falls into two categories:

  (a) System grounding or grounding one of the current carrying wires of the installation

  (b) Equipment grounding or grounding non-current carrying parts of the installation, such as the frames of electrical appliances and motors

T. Grounded wire--The neutral wire of a circuit, normally carrying current, but also connected to ground. This provides system grounding.

U. Grounding wire--Provides equipment grounding. A wire which does not carry current at all during normal operation (usually green or bare copper), but which does carry current in case of damage to or defect in the wiring system.

V. Short circuit--An improper connection between hot and neutral wires or between hot wires

W. Voltage drop--A loss in electrical pressure from its source to its point of use

X. U.L. (Underwriter's Laboratories)--A nationally accepted organization which tests all types of wiring materials and devices to make certain that they meet minimum standards for safety and quality

Y. Service transformer--An alternating current device used to change voltage from primary to secondary, such as: from 6,900 volts primary to 115 volts or 230 volts secondary; or from 115 volts primary to 230 volts secondary

Z. Single phase--A type of electric service available to most farms requiring one transformer between power supplier and customers

AA. Three phase--A type of electric service usually requiring two or three transformers between power supplier and customers

BB. Meter--An instrument which records the amount of electircal energy used (kilowatt-hours)

CC. Resistance--The property of a substance that opposes the flow of current (ohms)

INFORMATION SHEET

II. Benefits of using electricity

- A. Light
- B. Power
- C. Heat
- D. Cooling
- E. Communications
- F. Special controls

III. Electron movement

- A. Electrons--Ones having a negative charge
- B. Protons--Ones having a positive charge
- C. Negative electrons--Ones which move freely

  (NOTE: Negative electrons circulate about positive protons which form the nucleus of the atoms.)

IV. Sources of rural electricity

- A. Individual plant
- B. Central station and distribution lines (power generally purchased)

V. Means of transporting electricity (Transparency 1)

- A. Transmission lines--The lines that extend from generating station to substation or from substation to substation

  (EXAMPLE: Steel towers or double poles)

- B. Distribution lines--The lines beginning at a substation and extending out over the countryside, usually ranging from three to fifteen miles
- C. Service drop lines--The lines that run from a distribution line to the meter pole
- D. Feeder lines--The lines that run from the meter pole to the house

VI. Differences between 115-volt service and 230-volt service

- A. 115-volt service--Two lines running to the house
- B. 230-volt service--Three lines running to the house

VII. Types of power suppliers

INFORMATION SHEET

A. REA Cooperatives

B. Public or private companies

VIII. Local power supplier

A.

B.

IX. Ohm's law--All electric circuits have a definite relationship between the pressure, the electron motion, and the opposition (Transparencies 2 and 3)

A. Voltage = current x resistance

B. Voltage = E volts

C. Current = I amps

D. Resistance = R ohms

X. Electrical rates

A. Residential

B. Commercial

C. Special

D. Example of calculating residential rates:

1. First 20 kwh's at 7¢ per kwh
2. Next 20 kwh's at 5¢ per kwh
3. Next 60 kwh's at 3¢ per kwh
4. Next 120 kwh's at 2 1/2¢ per kwh
5. Over 220 kwh's at 1¢ per kwh

E. Customer used 300 kwh's

1.	First 20 kwh's at 7¢	=	$1.40
2.	Next 20 kwh's at 5¢	=	1.00
3.	Next 60 kwh's at 3¢	=	1.80
4.	Next 120 kwh's at 2 1/2¢	=	3.00
5.	Next 80 kwh's at 1¢	=	.80
6.	Total cost of 300 kwh's	=	$8.00

(Note: Instructor up date according to area)

XI. Types of kilowatt-hour meters (Transparency 4 and 5)

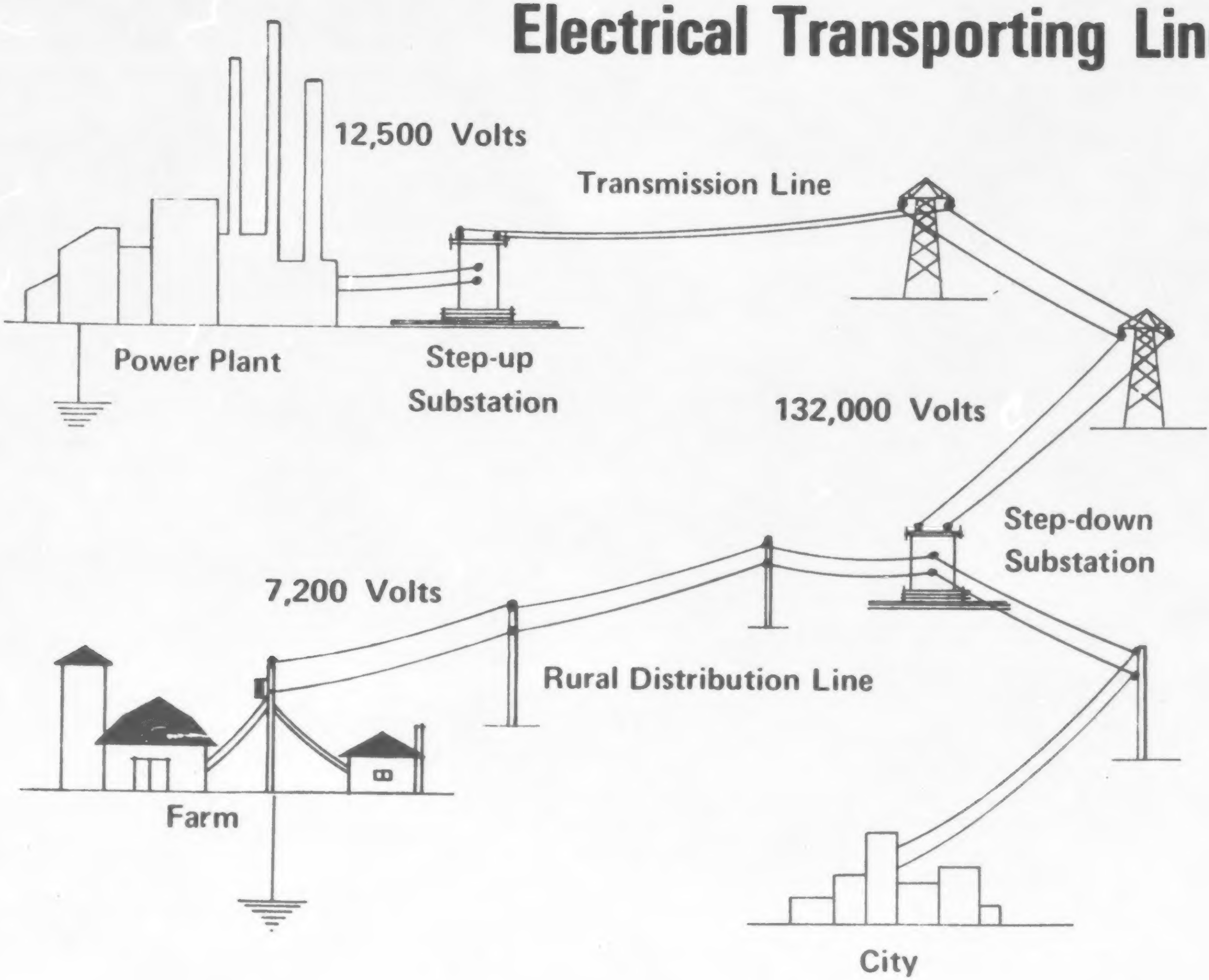
INFORMATION SHEET

- A. Cyclometer
- B. Pointer-dial

XII. Cost of operating electrical equipment

- A. Watts x hours of operation = Watt-hours
- B. Kilowatt-hours (kwh) = $\frac{\text{Watts x Hours}}{1000}$
- C. Motors
  1. Multiply 1,200 by hp rating if motor is smaller than one-half hp
  2. Multiply 1,000 by hp rating if motor is one-half hp or greater
  3. Example:
     - a. 1/4 hp motor x 1,200 = 300 watts
     - b. 300 watts x 2 hours of operation = 600 watt-hours
     - c. $\frac{600}{1000}$ = .6 kwh's

Electrical Transporting Lines


12,500 Volts
Transmission Line
Power Plant
Step-up Substation
132,000 Volts
Step-down Substation
7,200 Volts
Rural Distribution Line
Farm
City

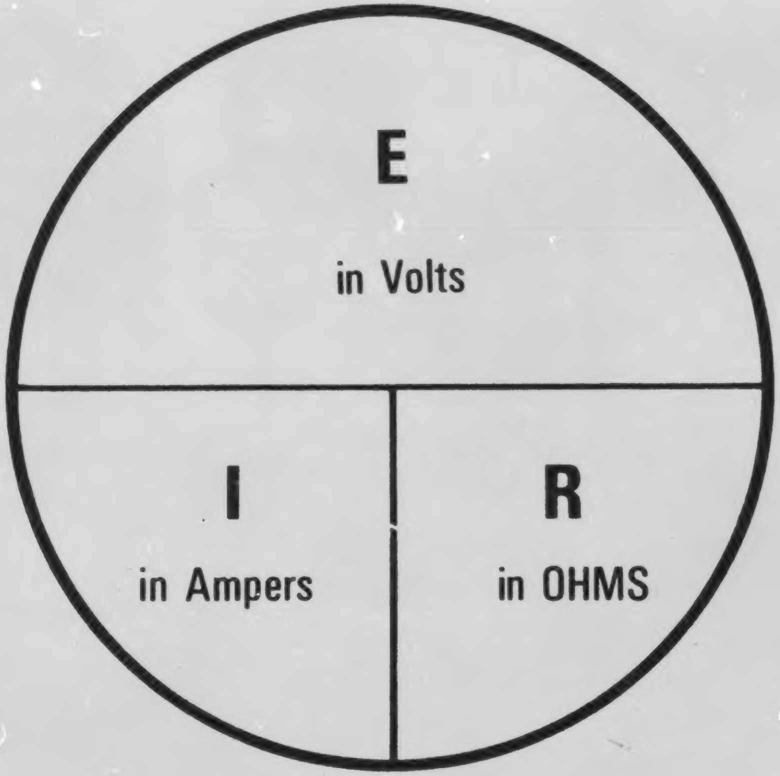
OHM'S Law

$$I = \frac{E}{R} \qquad \text{Amperes} = \frac{\text{Volts}}{\text{OHMS}}$$

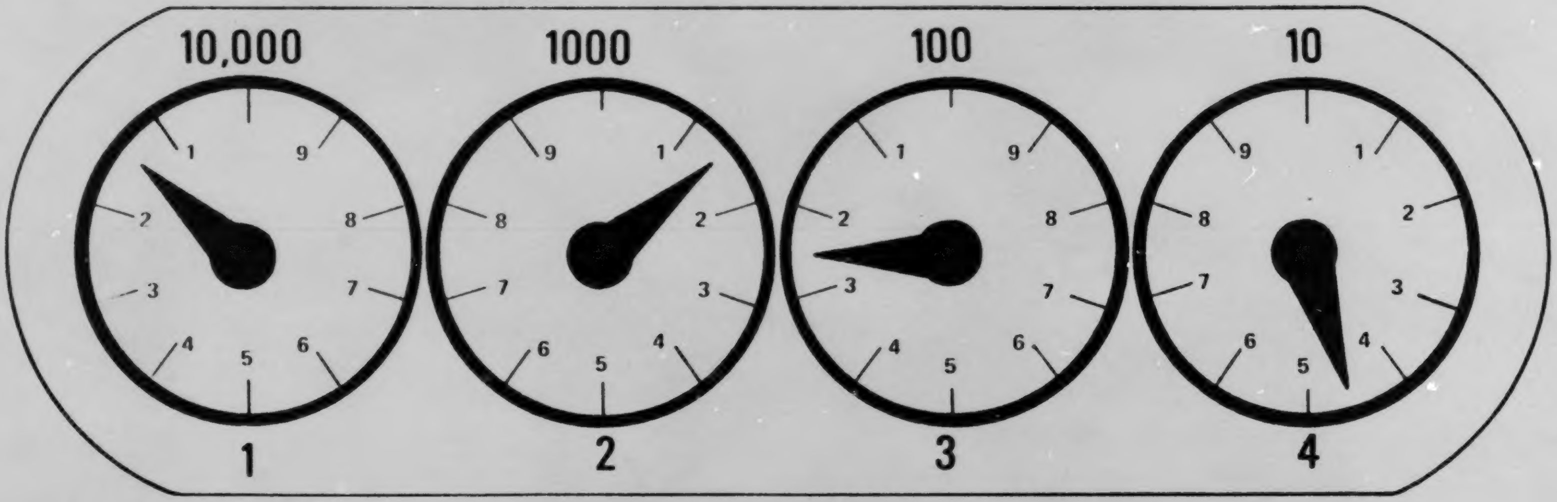
$$E = IR \qquad \text{Volts} = \text{Amperes} \times \text{OHMS}$$

$$R = \frac{E}{I} \qquad \text{OHMS} = \frac{\text{Volts}}{\text{Amperes}}$$

OHM'S Law

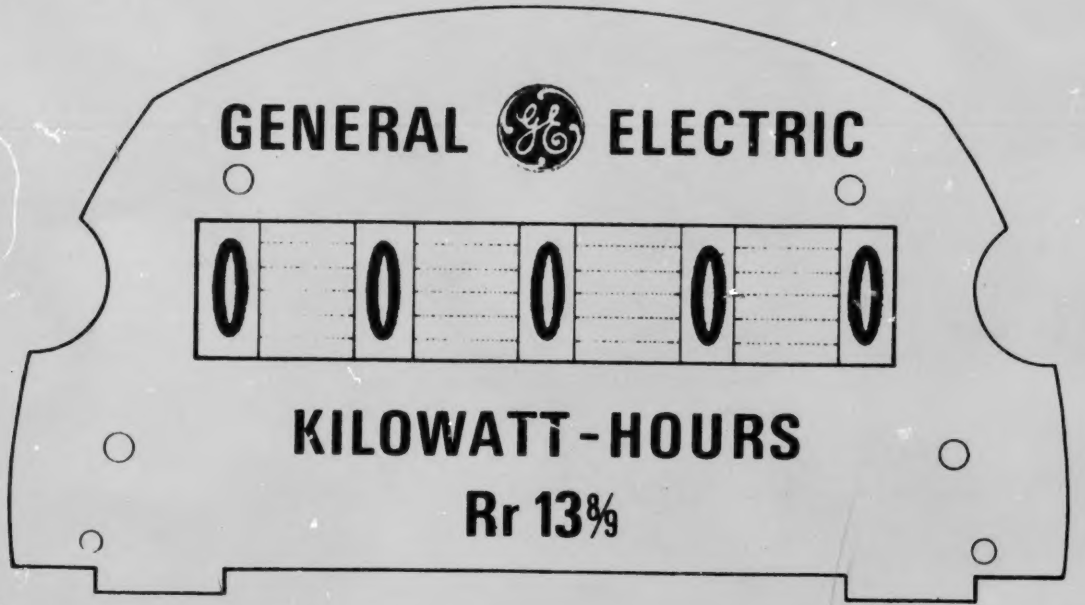

E
in Volts
I
in Ampers
R
in OHMS

Pointer-Dial Electric Meter



Read the last figure passed by the hand. When the hand seems to be on the number, the dial to the right should be consulted to see whether or not the number has been passed. Dial 4 shows the number of tenths. Dial 3 shows the number of one-hundredths. Dial 2 shows the number of one-thousandths.

Cyclometer Electric Meter


GENERAL ELECTRIC
0 0 0 0 0
KILOWATT-HOURS
Rr 13 8/9

TM 5

AM-19-B

FUNDAMENTALS OF ELECTRICITY
UNIT I

ASSIGNMENT SHEET NO. 1--CALCULATE COST OF OPERATING ELECTRICAL EQUIPMENT

Work each of the problems listed below. All problems should be worked using the average cost of 2 cents per kwh for electricity. Be sure to show your work.

1. How much would it cost to operate a 1/4-hp motor for 12 hours?

2. How much would it cost to operate a 2-hp motor for 10 hours?

3. How much would it cost to operate a 100-watt light bulb for a period of 12 hours?

4. An electric refrigerator requires 150 watts of electric power. It operates an average of four hours each day. How many kilowatt-hours would be used in 30 days, and how much would it cost for operation?

5. What would be the cost of operating a heat lamp that pulls 200 watts for 5 hours?

FUNDAMENTALS OF ELECTRICITY
UNIT I

ASSIGNMENT SHEET NO. 2--CALCULATE VOLTS, WATTS, AND AMPS

Work each of the problems below. When you have finished working the problems, turn in to the instructor.

1. Calculate ohms when:
    a. Amps 4 and volts 230 ____________________
    b. Amps 15 and volts 115 ____________________
    c. Amps 8 and volts 120 ____________________

2. Calculate volts when:
    a. Amps 12.5 and ohms 9.6 ____________________
    b. Amps 6 and ohms 19 ____________________
    c. Amps 3 and ohms 80 ____________________

3. Calculate amps when:
    a. Volts 125 and ohms 11 ____________________
    b. Volts 240 and ohms 11 ____________________
    c. Volts 120 and ohms 60 ____________________

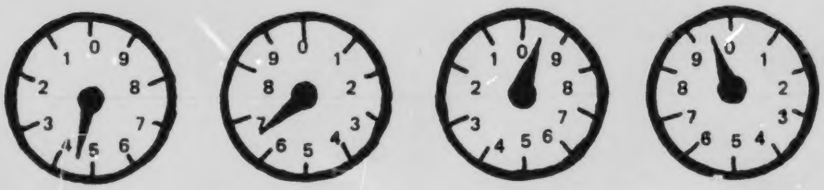
FUNDAMENTALS OF ELECTRICITY
UNIT I

ASSIGNMENT SHEET NO. 3--CALCULATE RESIDENTIAL ELECTRIC RATES

Work each of the problems below showing your work. Read the example of the electric kilowatt-hour meters, subtract the previous reading, and calculate the electric bill. Each problem should be figured using the rate listed below.

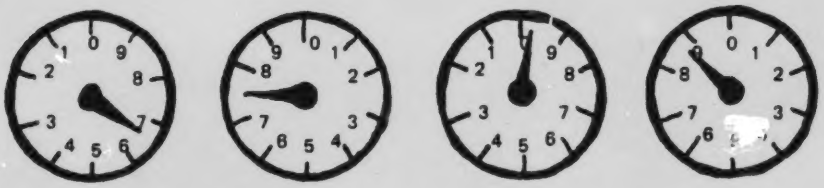
First 20 kwh's at 7 cents per kwh
Next 20 kwh's at 5 cents per kwh
Next 60 kwh's at 3 cents per kwh
Next 120 kwh's at 2 1/2 cents per kwh
Over 220 kwh's at 1 cent per kwh

Meter A



Reading
Previous reading 4459

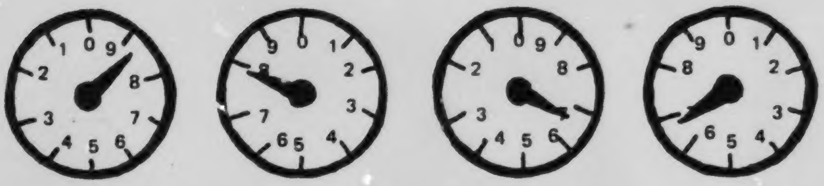
Meter B



Reading
Previous reading 5680

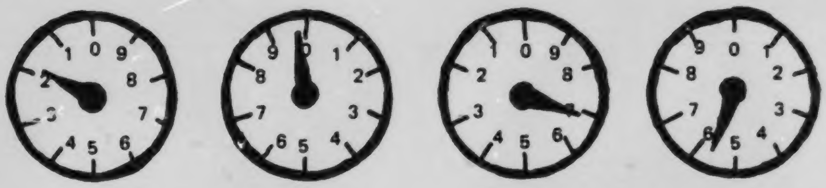
ASSIGNMENT SHEET NO. 3

Meter C


1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8
1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8

Reading
Previous reading 8450

Meter D


1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8
1 0 9 8 7 6 5 4 3 2
9 0 1 2 3 4 5 6 7 8

Reading
Previous reading 1000

FUNDAMENTALS OF ELECTRICITY
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

A. Assignment Sheet #1

1. 7.2¢
2. 40¢
3. 2.4¢
4. 36¢
5. 2¢

B. Assignment Sheet #2

1. a. 57.5
   b. 7.67
   c. 15.0

2. a. 120.0
   b. 114.0
   c. 240.0

3. a. 11.36
   b. 21.81
   c. 2.0

C. Assignment Sheet #3

Meter A	Reading	4699
	Previous reading	4459
		240 kwh
Bill price $7.40		
Meter B	Reading	6798
	Previous reading	5680
		1118 kwh
Bill price $16.18		
Meter C	Reading	8766
	Previous reading	8450
		316 kwh
Bill price $8.16		

28-B

Meter D Reading 1965

Previous reading 1000

965 kwh

Bill price $14.65

FUNDAMENTALS OF ELECTRICITY
UNIT I

TEST

1. Define the following terms.

   a. Volt--

   b. Switch--

   c. Conductor--

   d. Voltage drop--

   e. Meter--

   f. Resistance--

   g. Kilowatt--

   h. Watt--

   i. Electricity--

   j. Amp--

2. Name six benefits derived from the use of electricity.

   a.

   b.

   c.

   d.

   e.

   f.

3. Discuss the electron theory.

4. Name the two sources of rural electricity.

   a.

   b.

5. Name four means of transporting electricity.

   a.

   b.

   c.

   d.

6. Indicate by placing an "X" in the blank which of the following statements represents a 230-volt service.

   ______a. Two lines running to the house

   ______b. Three lines running to the house

7. Name two types of power suppliers.

   a.

   b.

8. What is the name of the power supplier that serves this school area?

9. What are the three types of electrical rates?

   a.

   b.

   c.

10. Define Ohm's law as related to electricity.

11. What are the two types of kilowatt-hour electric meters?

    a.

    b.

12. Calculate ohms:

    a. Amps = 10 and volts = 220 ______________________

    b. Amps = 8 and volts = 110 ______________________

13. Calculate volts:

    a. Amps = 10.5 and ohms = 15 ______________________

    b. Amps = 2 and ohms = 80 ______________________

14. Calculate amps:

    a. Volts = 115 and ohms = 10 ______________________

    b. Volts = 230 and ohms = 6 ______________________

15. Calculate the cost of 150 kilowatt-hours of electricity. Use the residential rates.

    First 20 kwh's at 7¢ per kwh
    Next 20 kwh's at 5¢ per kwh
    Next 60 kwh's at 3¢ per kwh
    Next 120 kwh's at 2 1/2¢ per kwh
    Over 220 kwh's at 1¢ per kwh

16. How many kilowatt-hours will a 200-watt pump use that runs for four hours?

17. How much will it cost to operate a 1/4-hp electric motor for eight hours if the average rate of electricity costs 4¢ per kwh?

FUNDAMENTALS OF ELECTRICITY
UNIT I

ANSWERS TO TEST

1. a. A unit of measure of electric pressure
   b. A device used to open or close a circuit
   c. The wires which carry the electricity, or through which electricity flows
   d. A loss in electrical pressure from its source to its point of use
   e. An instrument which records the amount of electrical energy in kilowatt-hours
   f. The property of a substance that opposes the flow of current
   g. 1,000 watts
   h. A unit of measure used in determining the rate of energy supplied
   i. A source of energy that can be easily converted into light, heat, or power
   j. A unit of measure of the rate of flow of electricity through a wire
2. a. Light
   b. Power
   c. Heat
   d. Cooling
   e. Communications
   f. Special tools
3. Discussion should contain the following information:
   a. Electrons have negative charge
   b. Protons have positive charge
   c. Negative electrons move freely
   d. Negative electrons circulate about positive protons which form the nucleus of the atoms

4. a. Individual plant

b. Central station and distribution lines

5. a. Transmission lines

b. Distribution lines

c. Service drop lines

d. Feeder lines

6. b.

7. a. REA Cooperatives

b. Public or private companies

8. ________________________________

9. a. Residential

b. Commercial

c. Special

10. All electric circuits have a definite relationship between the pressure, the electron motion, and the opposition.

11. a. Cyclometer

b. Pointer-dial

12. a. 22.0 ohms

b. 13.7 ohms

13. a. 157.5 volts

b. 160.0 volts

14. a. 11.5 amps

b. 38.3 amps

15. $5.45

16. .8 kwh's

17. 9.6¢

ELECTRICAL SAFETY
UNIT II

UNIT OBJECTIVE

After completion of Unit II, the student should be able to demonstrate safety practices in working with electricity to protect life and property. The student should be able to recognize danger areas when surveying the home. This knowledge will be evidenced through demonstration and by scoring one hundred percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Write the definition of five terms dealing with electrical safety.
2. Name five sources of electrical defects in equipment.
3. Name the two major causes of electrical accidents.
4. Name three ways of freeing a person that is receiving an electrical shock.
5. Discuss in a short paragraph the danger and damage caused by improperly using electricity and electrical equipment.
6. Discuss in a short paragraph the type of first aid that should be given to a person who has just received an electrical shock.
7. Match types of fires to the correct definition of each.
8. Select the proper fire extinguishers to use in controlling fire.
9. Select from a list of terms or statements the one that contributes to death due to electrical shock.
10. Identify the three types of common fuses.
11. Name five sure signs that wiring is out-of-date.
12. Name the three reasons why circuits fail.
13. Identify four types of circuit protection devices.
14. Survey your home for safe and unsafe electrical conditions.
15. Demonstrate the ability to use the National Electrical Code according to the "Official Interpretations" of the intent of the code.

ELECTRICAL SAFETY
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objectives.

  B. Provide students with information and assignment sheets and a copy of the NEC.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Counsel with students about safe and unsafe working conditions of electricity.

  G. Demonstrate the procedures for using the National Electrical Code.

  H. Give test.

II. Students:

  A. Read objectives.

  B. Study information sheets.

  C. Complete assignment sheets.

  D. Survey home for safe and unsafe electrical conditions.

  E. Take test

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheets

  C. Transparency masters

    1. TM 1-2--Safety Precautions

2. TM 3--Types of Common Fuses
3. TM 4--Circuit Protection Devices

D. Assignment sheets

1. Assignment Sheet No. 1--Survey Electrical Conditions on the Home
2. Assignment Sheet No. 2--Use the National Electrical Code

E. Answers to Assignment Sheet No. 2

F. Test

G. Answers to test

II. References:

A. *Simplified Electrical Wiring Handbook,* Sears-Roebuck and Company, Chicago, Illinois.

B. Brown, Robert H. *Farm Electrification.* New York: McGraw-Hill Book Company, Inc.

C. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook.* Danville, Illinois: The Interstate Printers and Publishers, Inc.

D. *Farm Electricity,* State of Tennessee, Department of Education, Division of Vocational Education.

E. *Basic Electricity and Practical Wiring Lessons,* The Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

F. Recht, J. L. *Accident Facts.* Chicago, Illinois: National Safety Council.

G. *National Electrical Code.* Boston, Massachusetts: National Fire Protection Association.

H. *Understanding Electricity and Electrical Terms.* American Association for Vocational Instructional Materials, Athens, Georgia, 1974. (Order from Agricultural Engineering Department, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, NE 68583.)

ELECTRICAL SAFETY
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Fuse--A safety device which breaks the flow of electrical current when a circuit becomes overloaded

      (NOTE: A fuse must be replaced when blown.)

   B. National Electric Code--A handbook that sets minimum standards for wiring and materials

   C. Test lamp--A tool used in checking short circuits, hot lines, and voltages

   D. Fusetron--A double element time delay fuse designed to withstand momentary overloads

   E. Grounded wire (Ding)--A green or bare wire which serves as the third wire on 115-volt appliances to provide an easy path for electricity to flow from *hot* to ground in a *shorted* piece of equipment

   F. Circuit--A completed path through which electricity flows

   G. Circuit breaker--A safety device which breaks the flow of electrical current when a circuit becomes overloaded

      (NOTE: A circuit breaker may be reset.)

II. Electrical defects in equipment (Transparency 1)

   A. Ground wire missing, broken, improperly connected, or not connected at all

   B. Open conduits; switch boxes damaged or worn

   C. Worn, wet, or oily insulation causing short circuits

   D. Defective switches, receptacles, extension or lamp cords, and lamp sockets

      (CAUTION: When handling lamp socket, keep bulb intact.)

   E. Dirty, improperly adjusted electrical equipment

   F. Loose vibrating machine parts which might cause a short circuit

III. Major causes of electrical accidents

INFORMATION SHEET

A. Carelessness

B. Misuse

IV. Freeing a person-Electrical Shock (Transparency 2)

(NOTE: 120-240 volt)

A. Locate *line wire* or source of electrical current and disconnect

(CAUTION: Do not take hold of the person's body with your bare hand.)

B. Decide immediately whether it would be easier to move the person or move the conductor.

(CAUTION: If conductor is to be moved, use dry stick; if person's body is to be moved, use several thicknesses of paper or cloth as an insulator.)

C. With paper or cloth in hand, grasp the person's arm or leg and quickly pull him free of the conductor

D. Over 240 volts

(CAUTION: If you see a downed wire, assume it is *hot* and can kill you. Protect the scene by posting a guard to keep passersby at least 200 feet away, then immediately call your power supplier and give them the exact location of the trouble.)

Phone ______________________________

V. Electrical danger and damage

(NOTE: Figures are for the years 1968-1973 as compiled by the National Safety Council.)

A. 1,148 persons killed in 1973

B. Contributes to 3 to 4 percent of all accidental deaths

C. Destroyed $268,000,000 worth of property in 1972

(NOTE: Fixed services, fires due to wiring and equipment.)

D. Destroyed $61,200,000 worth of appliances in 1968

(NOTE: Power consuming appliances.)

INFORMATION SHEET

VI. Proper first aid

  A. Call doctor or ambulance immediately

  B. Treatment is mouth-to-mouth resuscitation and C.P.R.

  D. Treat for shock

VII. Types of fires

  A. Class A–Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish

  B. Class B--Fires that occur with flammable liquids, such as gasoline, oil, grease, paints, and thinners

  C. Class C--Fires that occur in or near electrical equipment, such as motors, switchboards, and electrical wiring

VIII. Types of fire extinguishers

  A. Pressurized water--Operates usually by squeezing a handle or trigger; used on Class A. fires

  B. Soda acid--Operates by turning extinguisher upside down; used on Class A fires

  C. Carbon dioxide (CO_2)--Operates usually by squeezing a handle, trigger; used on Class B or C fires

  D. Dry chemical--Operates usually by squeezing a handle, trigger, or lever; used on Class B or C fires

  E. Foam--Operates by turning extinguisher upside down; used on Class A and B fires

IX. Electrical death

  A. Current kills, not voltage

  B. Voltage is involved

  C. Example--Less than 1/4 ampere will stop the heart

  (NOTE: Current flowing in a 25-watt lamp at 115 volts is enough to stop the heart of an average man.)

X. Types of common fuses (Transparency 3)

  A. Plug

INFORMATION SHEET

B. Cartridge

C. Blade

XI. Sure signs that wiring is out-of-date

A. Fuses blow

B. Circuits trip

C. Lights dim, blink, flicker

D. Television picture wobbles

E. Appliances need longer heating time

F. Airconditioner fails to do its job

G. Motor slow to come up to normal speed

XII. Reasons why circuits fail

A. Circuit overloaded

B. Fuse or breaker too small

C. Short circuit

D. Wire broken

E. Equipment defective

XIII. Circuit protection devices (Transparency 4)

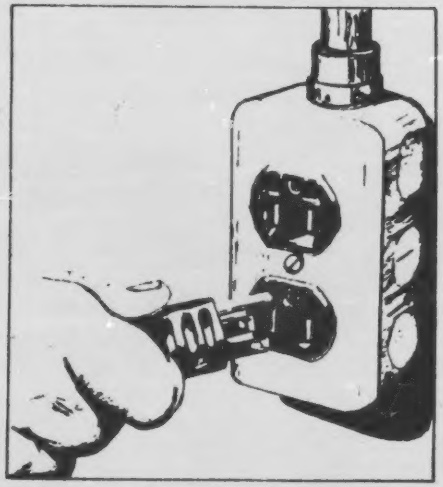
A. Fuse

B. Fusetron

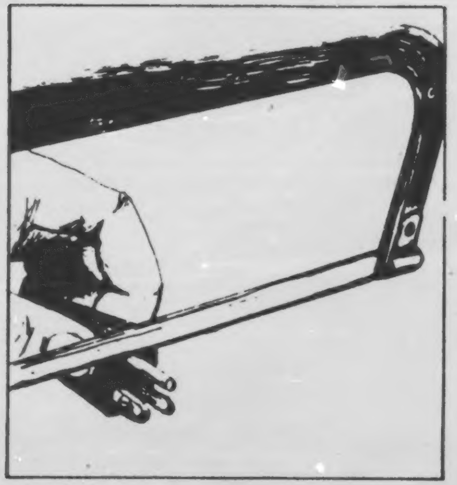
C. Fustat

D. Circuit breaker

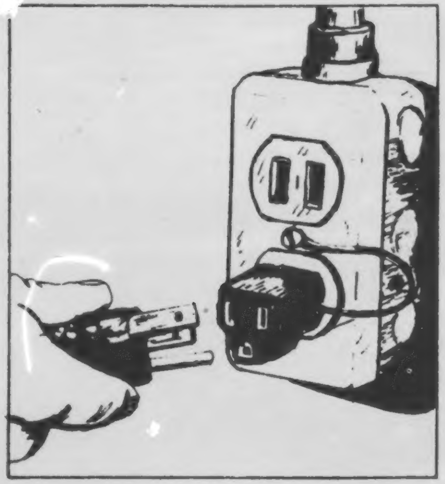
Safety Precautions



Modern homes have
three-wire receptacles.



Never cut off
the third prong.

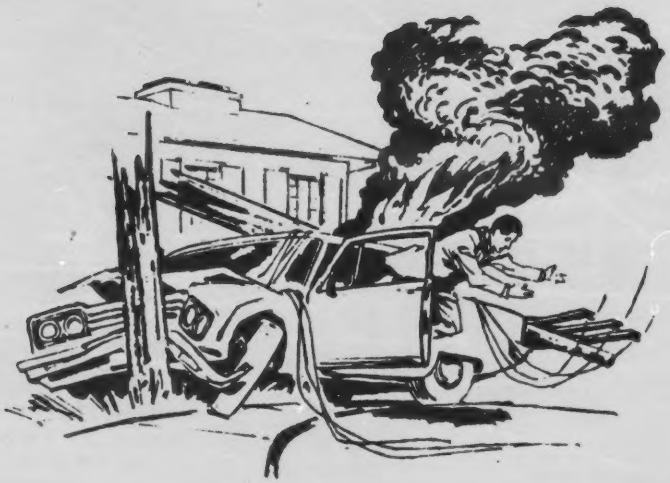


Use adaptor on
old-type receptacle.

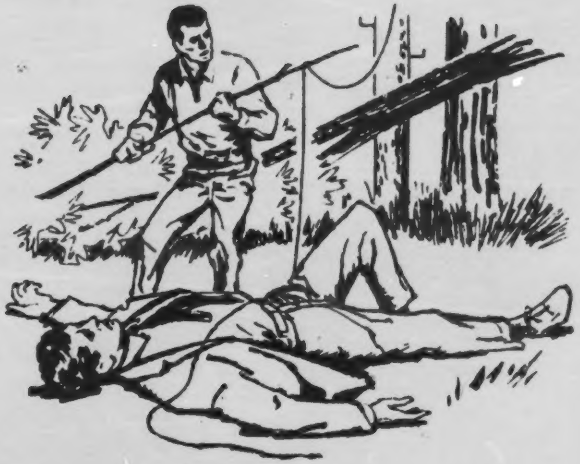
TM 1

AM-45-B

Safety Precautions

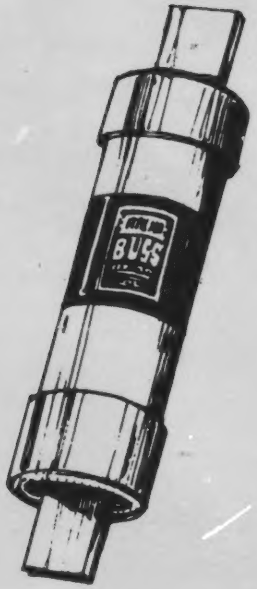


If a hot wire is in contact with a vehicle and the occupant must get out quickly, he should leap without touching the car again.

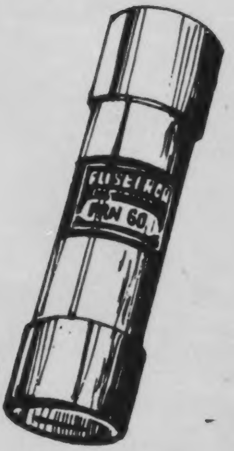


To remove a downed wire from a victim, use a non-conductor such as a long dry wooden or plastic pole or a very dry tree branch.

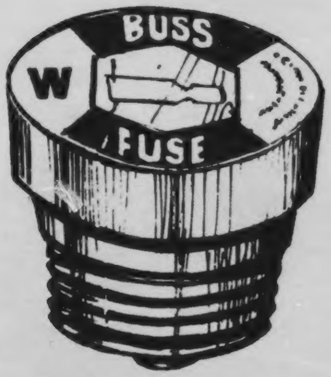
Types of Common Fuses



Blade

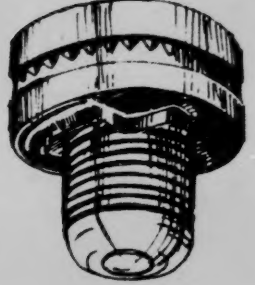

FUSETRON
FRN 60

Cartridge

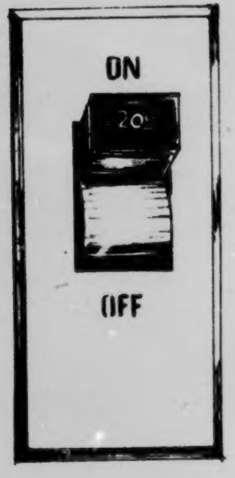


Plug

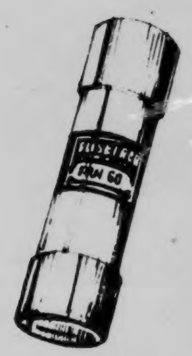
Circuit Protection Devices



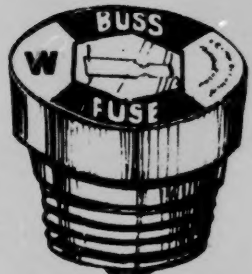
Fustat



Circuit Breaker


FUSETRON
FRN 60

Fusetron



Fuse

ELECTRICAL SAFETY
UNIT II

ASSIGNMENT SHEET NO. 1--SURVEY ELECTRICAL CONDITIONS

Answer each question below either *yes* or *no* if the question applies to your local situation. When completed return to class and turn in to instructor for discussion.

_____ 1. Are light cords hung over nails?

_____ 2. Are cords showing signs of wear?

_____ 3. Do switches work properly?

_____ 4. Are lamps touching flammable material?

_____ 5. Do lamps touch the wall?

_____ 6. Will clothing touch the light globes?

_____ 7. Is the lamp cord wrapped around bedstead or fastened to woodwork?

_____ 8. Are the floor lamp cords worn?

_____ 9. Can the floor lamp cords be stepped on?

_____ 10. Is the television set well away from curtains?

_____ 11. Is the television set well-ventilated in the back?

_____ 12. Is the electric warming pad approved?

_____ 13. Are cords found under the rug?

_____ 14. Are there enough electrical outlets?

_____ 15. Are wires strung through doors?

_____ 16. Are any wall receptacles broken?

_____ 17. Are all appliances Underwriters' Laboratories approved?

_____ 18. Is the refrigerator motor clean?

_____ 19. Is the ventilating fan clean?

_____ 20. Do fuses "blow" and breakers trip when appliances are connected? (If so, circuit is overloaded.)

_____ 21. Is the pressing iron in good order?

ASSIGNMENT SHEET NO. 1

_____ 22. Are signal lights working properly on appliances?

_____ 23. Is washing machine in good order? Does the cord show signs of wear?

_____ 24. Are the motors of dryer and washing machine free of lint and oil?

_____ 25. Is the lighting circuit fuse or breaker larger than 15 ampere?

_____ 26. Have fuses or circuit breakers been tampered with? (Pennies or other forms of dangerous substitutes used?)

_____ 27. Is main switch clean and in good order?

_____ 28. Is the panel switch door kept closed?

_____ 29. Are extra fuses kept on hand?

_____ 30. Are overhead wires to outbuildings properly supported and high enough for proper clearance of vehicles passing under such wires? (10 feet above walkways, 18 feet above driveways)

_____ 31. Are outbuildings properly grounded for lighting protection?

ELECTRICAL SAFETY
UNIT II

ASSIGNMENT SHEET NO. 2--USE THE NATIONAL ELECTRICAL CODE

The following statements are based on the National Electrical Code. Each question should be answered either *true* or *false*, depending on the *official interpretation* of the code.

1. Where the service-entrance conductors are paralleled in two or more raceways, the size of the bonding jumper for each raceway shall be based on the size of service conductors in each raceway. ______________
2. The rating of any one portable appliance shall not exceed 50% of the branch circuit rating. ______________
3. The smallest size wire permitted to be used for a run overhead from house to garage 45 feet away is No. 10. ______________
4. All circuits supplying gasoline dispensing pumps shall be controlled by a double pole disconnecting means. ______________
5. In clothes closets, wall lights may be installed above door. ______________
6. All appliances must be provided with a disconnecting means. ______________
7. Threadless couplings and fittings are approved in Class 1. ______________
8. All major exposed metal parts of a mobile home must be bonded to the groundings terminal of the distribution panel. ______________
9. Electric ranges and clothes dryers in a mobile home may be connected with a four-wire cord. ______________
10. The NEC permits the use of overcurrent devices which employ the multiple connection of fuses. ______________
11. Splices and taps may be located within fixture arms or stems. ______________
12. Underground cable run under a building shall be in a raceway that is extended beyond the outside wall of the building. ______________
13. A grounding conductor may be run in the same metal raceway with other conductors of the system to which it is connected. ______________
14. Circuits of less than 50 volts need not be grounded under any conditions. ______________
15. Circuit breakers and plug fuses installed in residential occupancies on circuits of 20 amperes or less shall be of the time-delay type. ______________

ASSIGNMENT SHEET NO. 2

16. Individual branch circuits may supply any loads. ________________

17. The installation of grounding type outlets shall not be used as a requirement that all portable equipment be of the grounded type. ________________

18. The minimum size service drop conductor shall not be smaller than No. 8 copper or equivalent except for a limited load. ________________

19. Fixture conductors shall not be smaller than No. 18 AWG. ________________

20. All splices other than factory splices shall be made in properly installed junction boxes approved for the location. ________________

Questions 1-10: Courtesy *iaei News*, International Association of Electrical Inspectors

ELECTRICAL SAFETY
UNIT II

ANSWERS TO ASSIGNMENT SHEET #2

1. False--Section 250-94
2. False--Section 210-24 (a)
3. True--Section 730-6 (a)
4. True--Section 514-5
5. True-Section 410-8 (a-1)
6. True--Section 422-20
7. False--Section 501-4
8. True--Section 550-9 (c)
9. True--Section 550-9 (a-2)
10. False--Section 240-14
11. False--Section 410-25
12. True--Section 300-7
13. True--Section 250-98
14. False--Section 250-8
15. True--Section 240-4
16. True--Section 210-24
17. True--Section 210-20
18. True--Section 230-23
19. True--Section 410-8
20. True--Section 422-77

ELECTRICAL SAFETY
UNIT II

TEST

1. Define the following terms.
   a. Test lamp--
   b. Grounded ding wire--
   c. Circuit--
   d. Fuse--
   e. National Electrical Code--
2. Name five sources of electrical defects in equipment.
   a.
   b.
   c.
   d.
   e.
3. Name two major causes of electrical accidents.
   a.
   b.
4. Name three ways of freeing a person that is receiving an electrical shock.
   a.
   b.
   c.
5. Discuss in a short paragraph the danger and damage caused by improperly using electricity and electrical equipment.

6. Discuss in a short paragraph the type of first aid that should be given to a person who has just received an electrical shock.

7. Match the types of fires with the correct definition.

_____a. Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners

_____b. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

_____c. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

1. Class C
2. Class B
3. Class A

8. From the list of fire extinguishers below select the ones you would use to control an electrical fire by circling the correct letters.

a. Soda acid

b. Carbon dioxide

c. Foam

d. Dry chemical

e. Pressurized water

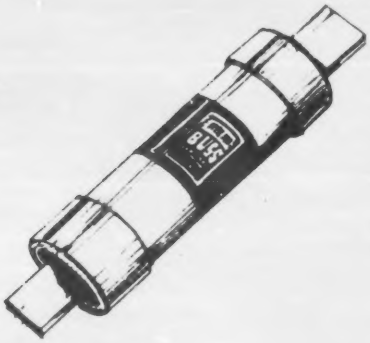
9. Place an "X" in front of the following terms which contribute to death due to receiving an electrical shock.

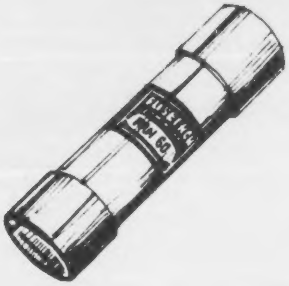
a. Wattage

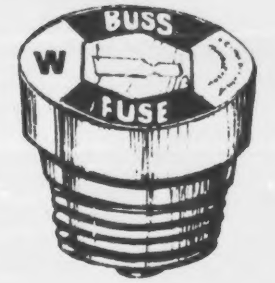
b. Amperes

c. Voltage

10. Identify the following types of fuses.







a. ____________ b. ____________ c. ____________

11. Name five sure signs that wiring is out-of-date.

a.

b.

c.

d.

e.

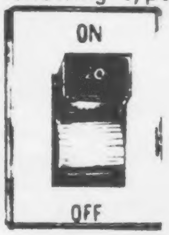
12. Name three reasons for circuit failure.

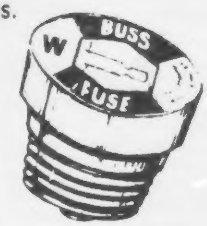
a.

b.

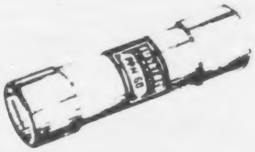
c.

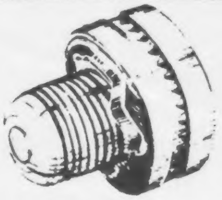
13. Identify the following types of circuit protection devices.





a. ______________________________ b. ______________________________





c. ______________________________ d. ______________________________

ELECTRICAL SAFETY
UNIT II

ANSWERS TO TEST

1. a. A tool used in checking short circuits

   b. A green or bare wire which serves as the third wire on 115-volt appliances to provide an easy path for electricity to flow from *hot* to ground in a *shorted* piece of equipment

   c. A completed path through which electricity flows

   d. A safety device which breaks the flow of electrical current when a circuit becomes overloaded

   e. An organization that sets minimum standards for wiring and materials

2. Any five of the following:

   a. Ground wire missing, broken, improperly connected, or not connected at all

   b. Open conduits; switch boxes damaged or worn

   c. Worn, wet, or oily insulation causing short circuits

   d. Defective switches, receptacles, extension cords, and lamp sockets

   e. Dirty, improperly adjusted electrical equipment

   f. Loose vibrating machine parts which might cause a short circuit

3. a. Carelessness

   b. Misuse

4. a. Locate *line wire* or source of electric current and disconnect

   b. Decide whether to move person or move conductor

   c. With some type of insulator in your hand, grasp person's arm or leg and quickly pull him free

5. Discussion should contain the following.

   a. 1,148 persons killed in 1973

   b. Contributes from 3 to 4 percent of all accidental deaths

c. Destroyed $268,000,000 worth of property in 1972

d. Destroyed $61,200,000 worth of appliances in 1968

6. Discussion should include the following statements.
   - a. Call doctor or ambulance immediately
   - b. Only treatment is mouth-to mouth resuscitation

7. a. 2
   - b. 1
   - c. 3

8. b.
   - d.

9. b.

10. a. Blade
    - b. Cartridge
    - c. Plug

11. Any five of the following:
    - a. Fuses blow
    - b. Circuit trips
    - c. Lights dim, blink, flicker
    - d. Television picture wobbles
    - e. Appliances need longer heating time
    - f. Airconditioner fails to do its job
    - g. Motor slow to come up to normal speed

12. Any three of the following:
    - a. Circuit overloaded
    - b. Fuse or breaker too small
    - c. Short circuit

d. Wire broken

e. Equipment defective

13. a. Breaker

b. Fuse

c. Fusetron

d. Fustat

ELECTRICAL WIRING PRACTICES
UNIT III

UNIT OBJECTIVE

After completion of Unit III, the student should be able to identify electrical tools, devices, and conductors. The student should be able to recognize factors determining correct wire size to use and select wire size for safety, economy, and quality service, and demonstrate the ability to wire receptacles and lighting outlets. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define five terms associated with electrical wiring.
2. Identify ten tools used in electrical wiring when given the tools or a drawing illustrating the tools.
3. Identify the electrical devices when given the devices or a drawing.
4. Identify ten conductors as either wire, cord, or cables; tell type of insulation, wire size, AWG, or cir. mills; and give the use of each.
5. Name three factors affecting voltage drop.
6. Name the three-step procedure to follow in wiring.
7. Draw a schematic diagram showing two lights connected in a series and controlled by a switch.
8. Distinguish between wiring diagrams and schematic diagrams.
9. Demonstrate the procedure for performing the following jobs:
    a. Wire a lighting outlet controlled by a single-pole switch.
    b. Wire three duplex receptacles using non-metallic cable.
    c. Wire a lighting outlet controlled by two three-way switches.

ELECTRICAL WIRING PRACTICES
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheets with students.

  F. Demonstrate procedures for completing job sheets.

  G. Give test.

II. Students:

  A. Read objective sheet.

  B. Study information sheets.

  C. Demonstrate ability to complete procedures outlined in job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheets

  C. Transparency masters

    1. TM 1--Electrical Wiring Tools

    2. TM 2--Electrical Wiring Tools

    3. TM 3--Electrical Devices

  D. Job sheets

1. Job Sheet #1--Wire a Lighting Outlet Controlled by a Single-Pole Switch
2. Job Sheet #2--Wire Three Duplex Receptacles Using Non-Metallic Cable
3. Job Sheet #3--Wire a Lighting Outlet Controlled by Two Three-Way Switches

E. Test

F. Answers to test

II. References:

A. Brown, Robert H. Farm Electrification. New York: McGraw-Hill Book Company, Inc.

B. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. Farm Mechanics Text and Handbook. Danville, Illinois: The Interstate Printers and Publishers, Inc.

C. Farm Electricity, State of Tennessee, Department of Education, Division of Vocational Education.

D. Basic Electricity and Practical Wiring Lessons, The Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

E. National Electrical Code 1975. National Fire Protection Association, 470 Atlantic Ave., Boston, Mass. 02210

F. Understanding Electricity and Electrical Terms. American Association for Vocational Instructional Materials, Athens, Georgia, 1974. (Purchase from Agricultural Engineering Department, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska 68583.)

ELECTRICAL WIRING PRACTICES
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Conductors--The wires which carry the electricity or through which electricity flows

   B. Terminal--A device attached to the end of a wire or cable or to an electrical apparatus for convenience in making connections

   C. Schematic diagram--A step used in electrical wiring showing the connections that need to be made

   D. Wiring diagram--The plan which shows the electric circuit with items arranged and appearing so the job of connecting will be simplified

   E. Junction box--An outlet box with a blank cover used to contain splices of a circuit

   F. Cable--Two or more wires put together inside an overall covering

   G. Cord--Several small wires wrapped in insulation, then covered with another layer of insulation

   H. Outlet box--A box-like device which is used to bring the wires to the location where a switch or outlet is installed

   I. Receptacle outlet--A device which contains the splices when a circuit is tapped for an appliance or a light

   J. Conduit--A thin-walled steel pipe used to protect electrical wires

   K. Single-pole toggle switch--A switch used to break the current in a single place

   L. 3-Way switch--A switch used to control lights and motors from two different places

   M. 4-Way switch--A switch used to control lights and motors from three or more different places

   N. Wire gauge--A tool used to measure wire diameter

   O. Wire size--The measure of a wire diameter

   P. Wire--A single conductor which carries electricity

INFORMATION SHEET

II. Electrical wiring tools (Transparencies 1 and 2)

- A. Needle-nose pliers
- B. Lineman's pliers
- C. Diagonal pliers
- D. Wire strippers
- E. Screwdrivers
  - 1. Standard
  - 2. Phillips
- F. Pocket knife
- G. Hammer
- H. Wood chisel
- I. Electric drill
- J. Tape or rule
- K. Keyhole saw
- L. Hacksaw
- M. Test lamp
- N. Amp volt meter
- O. Vise-grip pliers
- P. Fish tape and reel
- Q. Conduit bender

III. Electrical devices (Transparency 3)

- A. Single element fuse, 30-amp, Edison plug type
- B. Time delay fuse, 25-amp, Edison plug type
- C. Time delay fuse, 40-amp, cartridge type
- D. Polarized heavy duty plug cap, 230-V., 15 amp

INFORMATION SHEET

E. Fuse box cover/grounded outlet for fractional hp motor protection

F. Single element fuse, 50-amp, cartridge type

G. 1/2" connector for NM cable

H. 15-amp duplex, 115/230-V., grounded receptacle, 3-wire

I. 15-amp duplex, 115-V. grounded receptacle, 3-wire

J. 50-amp, 115/230-V., cord receptacle cap

K. 50-amp, surface receptacle, 3-wire, 115/230-V.

L. 3-wire receptacle, 30-amp, 115/230-V., twist lock

M. Single-pole, single-throw 10-amp, toggle wall switch

N. Single-pole, double-throw, or 3-way, 10-amp, toggle wall switch

O. Crow foot polarized cord cap, 20-amp, 3-wire, 230-V.

P. Polarized twist lock plug cap, 20-amp, 115/230-V., 3-wire

Q. Handy box 1/2" knock-out and cover for toggle switch

R. Handy box 1/2" knock-out and cover for duplex receptacle

S. Wall box with clamps and beveled corners for switch or receptacle

T. 4" x 1 1/2"octagon box, 1/2" knock-outs for ceiling outlets or junction box

INFORMATION SHEET

IV. Conductors

NO. ITEM		TYPE	AM. WIRE GAUGE	USE	REFERENCE
A.	Wire	A(392)	16STD	Heating Appliances Within Apparatus-Dry Locations	Table 310 - 13 NEC*
B.	Wire	TW(140)	14	Inside of Conduit Dry and Wet Locations	Table 310 - 13 NEC
C.	Wire	USE	10	Trench-Lay - Under Ground	Table 310-13 & Art. 338 NEC
D.	Wire	TW(Low Voltage)	18	Low Voltage Alarm Or Relay Controls	
E.	Cord	HPN	16/2	Heater Cord	Article 400 NEC
F.	Cord	S	12/3	Hard Usage-Welders Large Motors	Article 400 NEC
G.	Cord	HC	16/2	Iron, Heaters	Article 400 NEC
I.	Cord	SV	18/2	Vacuum Cleaners-Mixers	Article 400 NEC
J.	Cable	Triplex	6/3	Outside-Overhead Service	
K.	Cable	UF	10/2	Underground-Feeder And Branch Circuits	Art. 339 NEC
L.	Cable	NM	14/2G	Inside-Dry Locations	Art. 336 NEC

V. Factors affecting voltage drop

A. Length of wire

B. Size of wire

C. Number of amps flowing through wire

D. Type of conductor

VI. Procedures to follow in wiring

A. Draw the schematic diagram

---

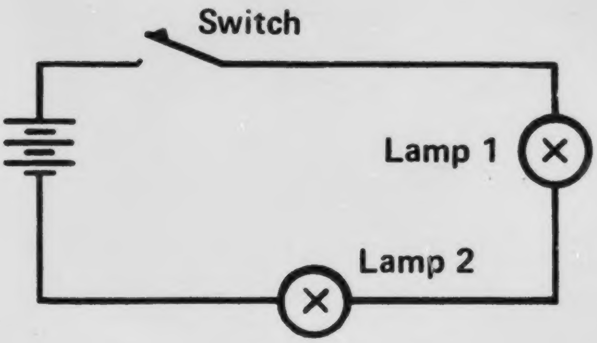
*NEC - National Electric Code, 1975

INFORMATION SHEET

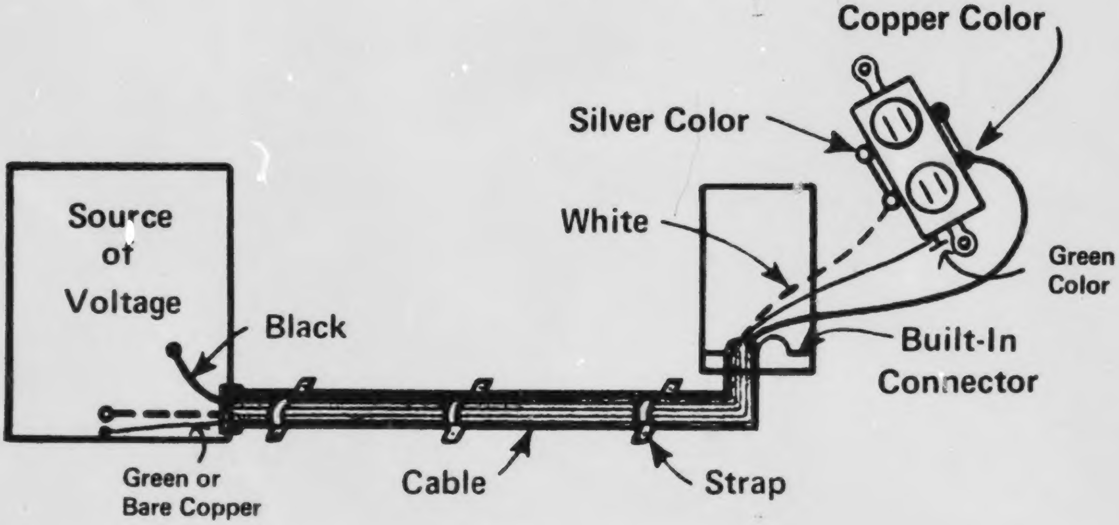
B. Draw the wiring diagram

C. Install wire according to wiring diagram

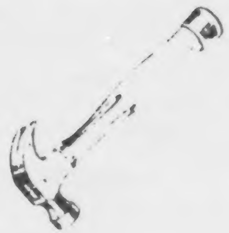
VII. Schematic diagram

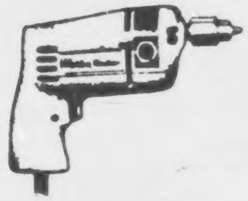

Switch
Lamp 1
Lamp 2

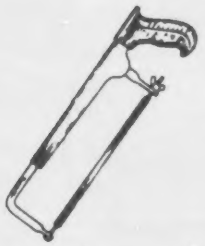
VIII. Wiring diagram

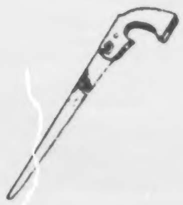

Copper Color
Silver Color
White
Green Color
Source of Voltage
Black
Built-In Connector
Green or Bare Copper
Cable
Strap

Electrical Wiring Tools

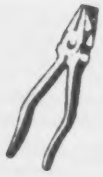

Hammer

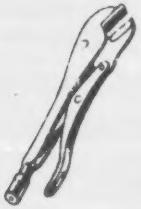

Electric Drill

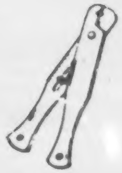

Hacksaw

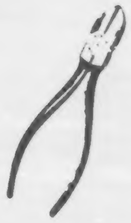

Keyhole Saw

Needle Nose Pliers

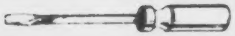

Lineman's Pliers


Vise-Grip Pliers


Wire Cutter,
Stripper


Diagonal Pliers

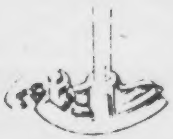
Electrical Wiring Tools



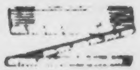
Screwdriver

Wood Chisel

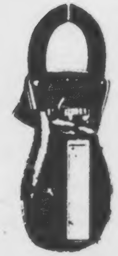
Test Light



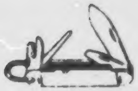
Conduit Bender



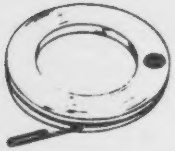
6-foot Folding Rule



Amp Volt Meter

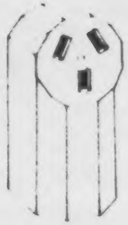


Jackknife

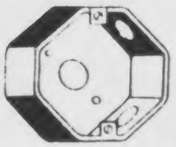


Fish Tape and Reel

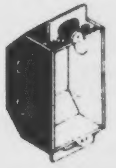
Electrical Devices



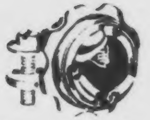
50 Amp 115/230 v. Cord
Receptacle Cap



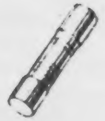
Octagon Box



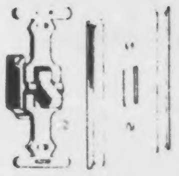
Beveled Corners
Wall Box



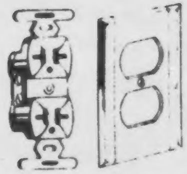
Connector



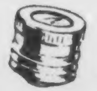
Time Delay Fuse
40 Amp Cartridge Type



Toggle Wall Switch
and Cover



Duplex Receptacle
and Cover



Single Element Fuse
30 Amp
Edison Plug Type

ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #1--WIRE A LIGHTING OUTLET CONTROLLED BY A SINGLE-POLE SWITCH

I. Tools and equipment

A. Standard screwdriver

B. Lineman's pliers

C. Needle-nose pliers

D. Knife or strippers

II. Materials

A. Lighting outlet

B. Octagon box

C. Single-pole toggle switch

D. Handy box for single-pole switch

E. 2 pieces of No. 12/2 NM wire, 2 feet long

F. 1 piece of 2' x 3' x 1/4" plywood

III. Procedures

A. Attach box for single pole switch to demonstration board (Figure A)

B. Remove knock-out plugs and loosen screw in box and place one piece of NM wire under plate and allow approximately six inches extending from box (Figure B)

C. Remove five inches of outside insulation on wire (Figure C)

D. Tighten screw in box

E. Remove approximately 1" to 1 1/2" of insulation from each wire

(CAUTION: This should be done in such a manner to not scratch or mark the wire.)

F. Secure octagon box to demonstration board and remove knock-out plugs which are located directly across from each other (Figure A)

JOB SHEET NO. 1

G. Using the remainder of wire extending from handy box, run to octagon box, and use the same procedures for fastening wire to octagon box as in fastening to handy box

H. Remove five inches of outside insulation from wire

I. Remove approximately 1 1/2" of insulation from each wire

J. Using the extra piece of wire, remove six inches of outside insulation and 1 1/2" of insulation from each wire and place through octagon box and secure to box

(NOTE: The end of wire extending from octagon box will be connected to electrical source.)

K. Connect single-pole toggle switch to wires extending from handy box

(NOTE: Wires should be placed around terminals on switch according to the way the screw tightens.) (Figure D)

L. Connect black *hot wire* to brass side of lighting outlet

(NOTE: Procedures should be the same for connecting the terminals.) (Figure E)

M. White wire from switch should be connected to black wire which is designated as the source wire

(NOTE: This connection should be made with a pigtail splice and by using an insulation cap.) (Figure F)

N. White source wire should be connected to the silver terminal on lighting outlet (Figure E)

O. Connect the green (or bare) grounding wires to each metal item in the circuit. (Figure H)

(NOTE: If you are using non-metallic boxes, there is no need for connecting the bare wire to the box itself)

P. Place wires in handy box and fasten toggle switch to box (Figure G)

Q. Turn switch off and on to see if wiring is correct

R. Connect wire extending from octagon box to the electrical source

(CAUTION: Be sure to have instructor's approval before performing this step.)

JOB SHEET #1

IV. Diagram of procedure

Figure A

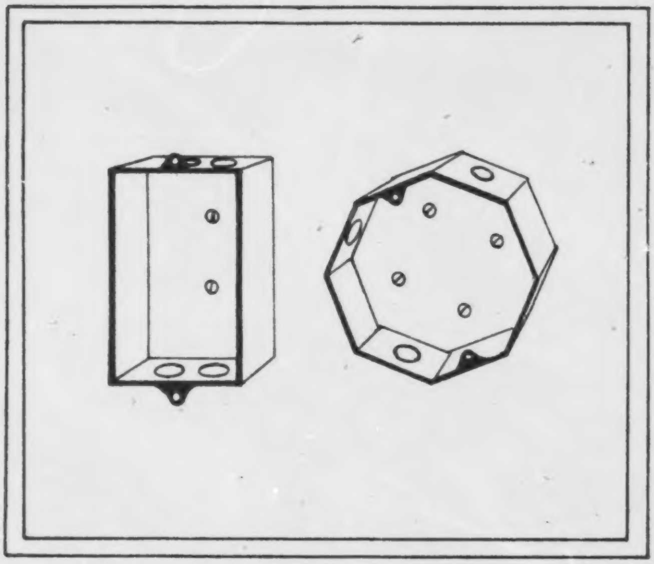


Figure B

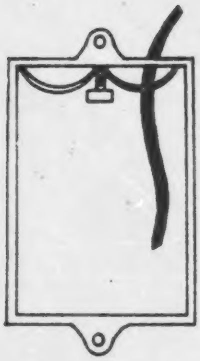
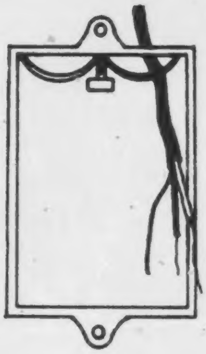


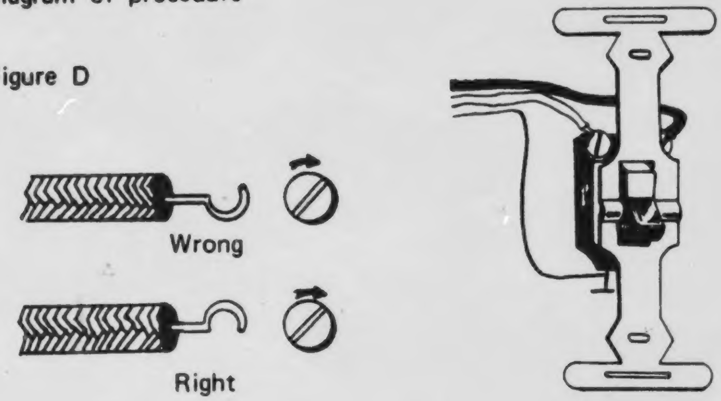
Figure C



JOB SHEET #1

IV. Diagram of procedure

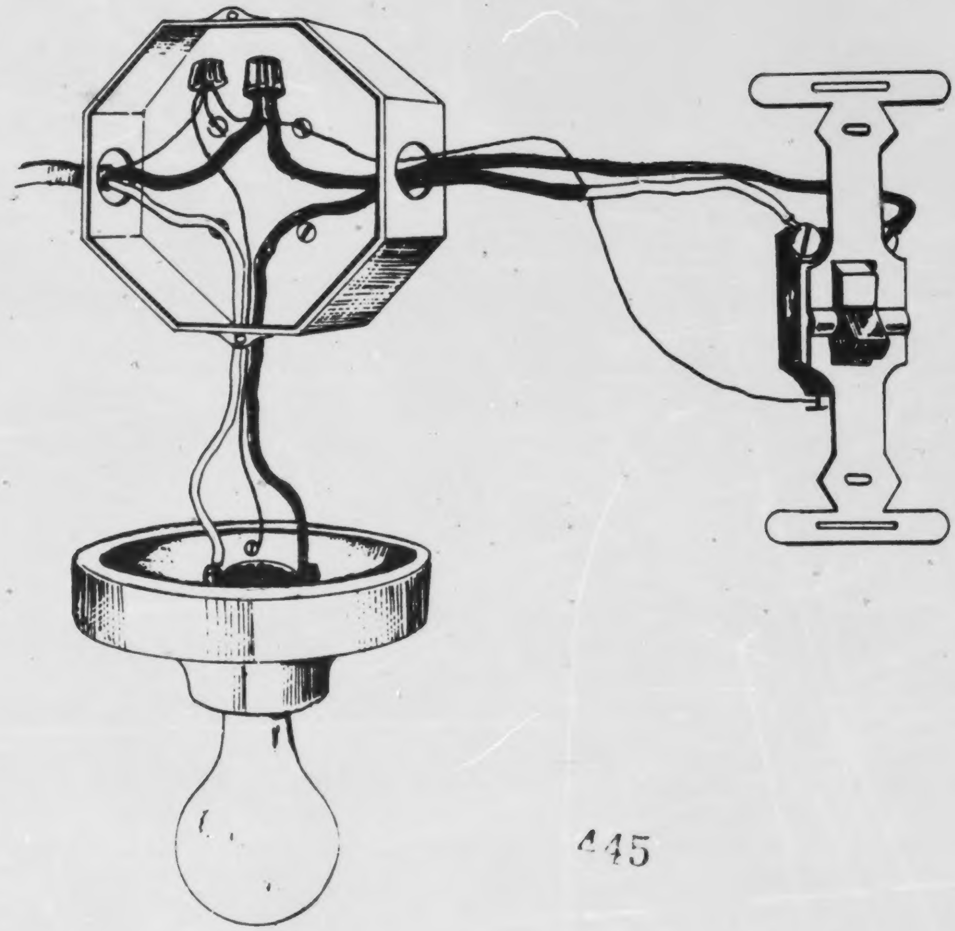
Figure D



Wrong

Right

Figure E



JOB SHEET #1

IV. Diagram of procedure

Figure F

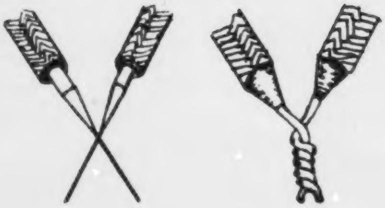


Figure G

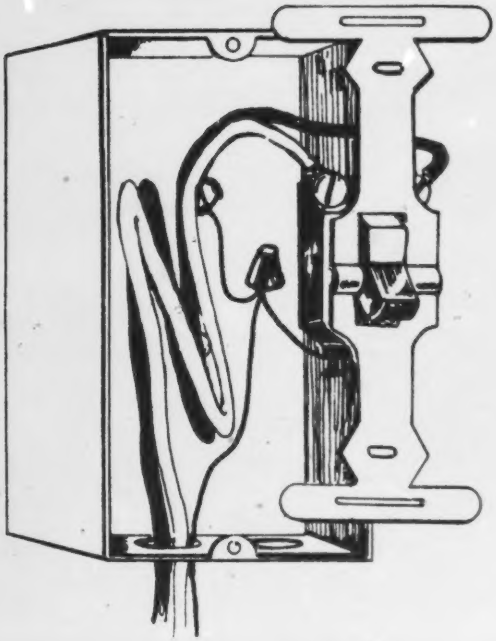
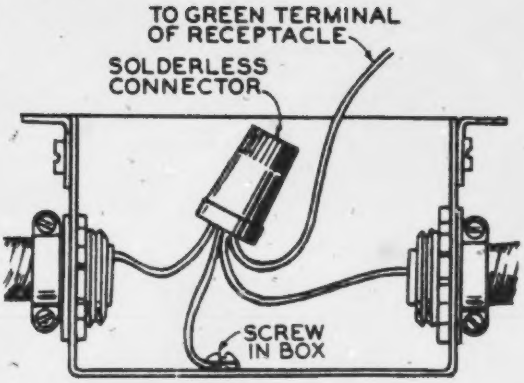


Figure H


TO GREEN TERMINAL OF RECEPTACLE
SOLDERLESS CONNECTOR
SCREW IN BOX

ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #2--WIRE THREE DUPLEX RECEPTACLES USING NON-METALLIC CABLE

I. Tools and equipment

A. Standard screwdriver

B. Lineman's pliers

C. Needle-nose pliers

D. Knife or strippers

II. Materials

A. Three duplex receptacles

B. Three flush wall boxes for receptacles

C. Three duplex receptacle cover plates

D. One piece of plywood, 1/4" x 2' x 3'

E. Three pieces of No. 12/2 g NM wire 24 inches long

(NOTE: Number wires 1, 2, and 3.)

III. Procedure

A. Secure receptacle flush wall boxes to demonstration board (Figure A)

B. Remove knock-out plugs on box A and B on both ends, but remove only one knock-out on box C

C. Loosen screw inside all three handy boxes (Figure B)

D. Starting with box C, place wire one under screw plate allowing six inches to extend from box and then tighten screw

(CAUTION: Tighten screw firmly but do not cut insulation.) (Figure C)

E. Place remaining end of wire one under screw plate of box B allowing six inches to extend from the box and tighten screw

F. Place wire two in box B under screw plate of box allowing six inches to extend from the box and tighten screw

JOB SHEET #2

G. Place the remaining end of wire two in box A under screw plate of box allowing six inches to extend from box and tighten screw

H. Place wire one under screw plate of box A allowing six inches to extend from the box

I. Remove approximately five inches of the outside insulation on each wire extending from handy box

(NOTE: Remember to use caution in removing insulation.)

J. Remove approximately 1 to 1 1/2" of insulation from each wire extending from handy boxes

(NOTE: Remember to use caution in removing insulation from wires.)

K. Starting with box C, attach black *hot wire* to brass side of receptacle

(NOTE: Wire should be placed around terminals according to the direction the screw tightens.) (Figure D)

L. Attach white *neutral wire* to silver side of receptacle (Figure E)

M. Attach green *ground wire* to the top of receptacle (Figure E)

N. Same procedures should be followed for attaching wires to receptacles A and B

O. Assemble wires with receptacle and place in handy box; attach cover plate

P. Check with instructor for approval before attaching wire three to electrical source

JOB SHEET #2

IV. Diagram of procedure

Figure A

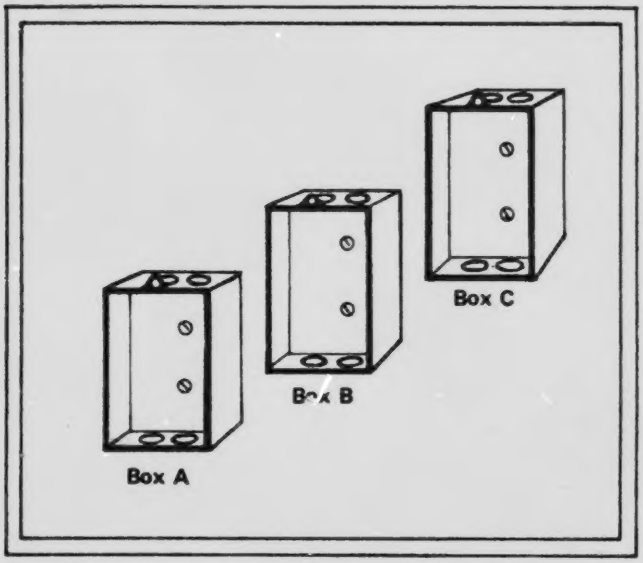

Box A
Box B
Box C

Figure B

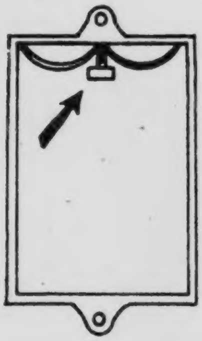
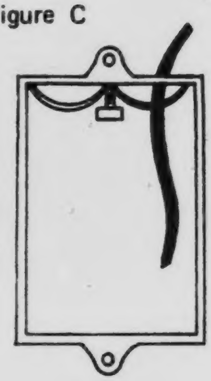


Figure C



JOB SHEET #2

IV. Diagram of procedure

Figure D

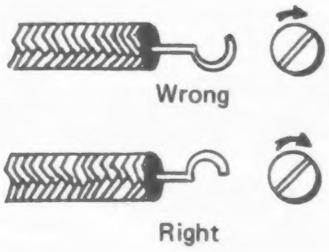
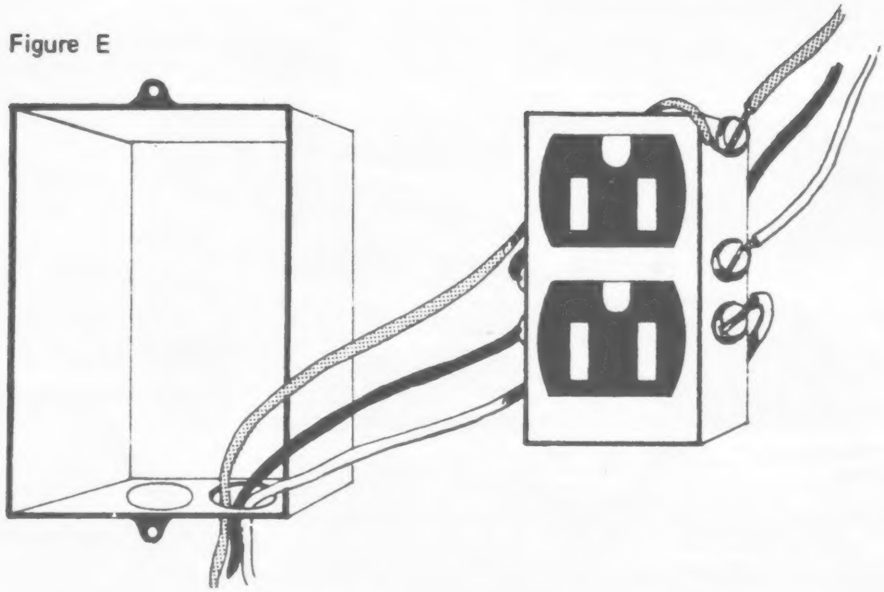
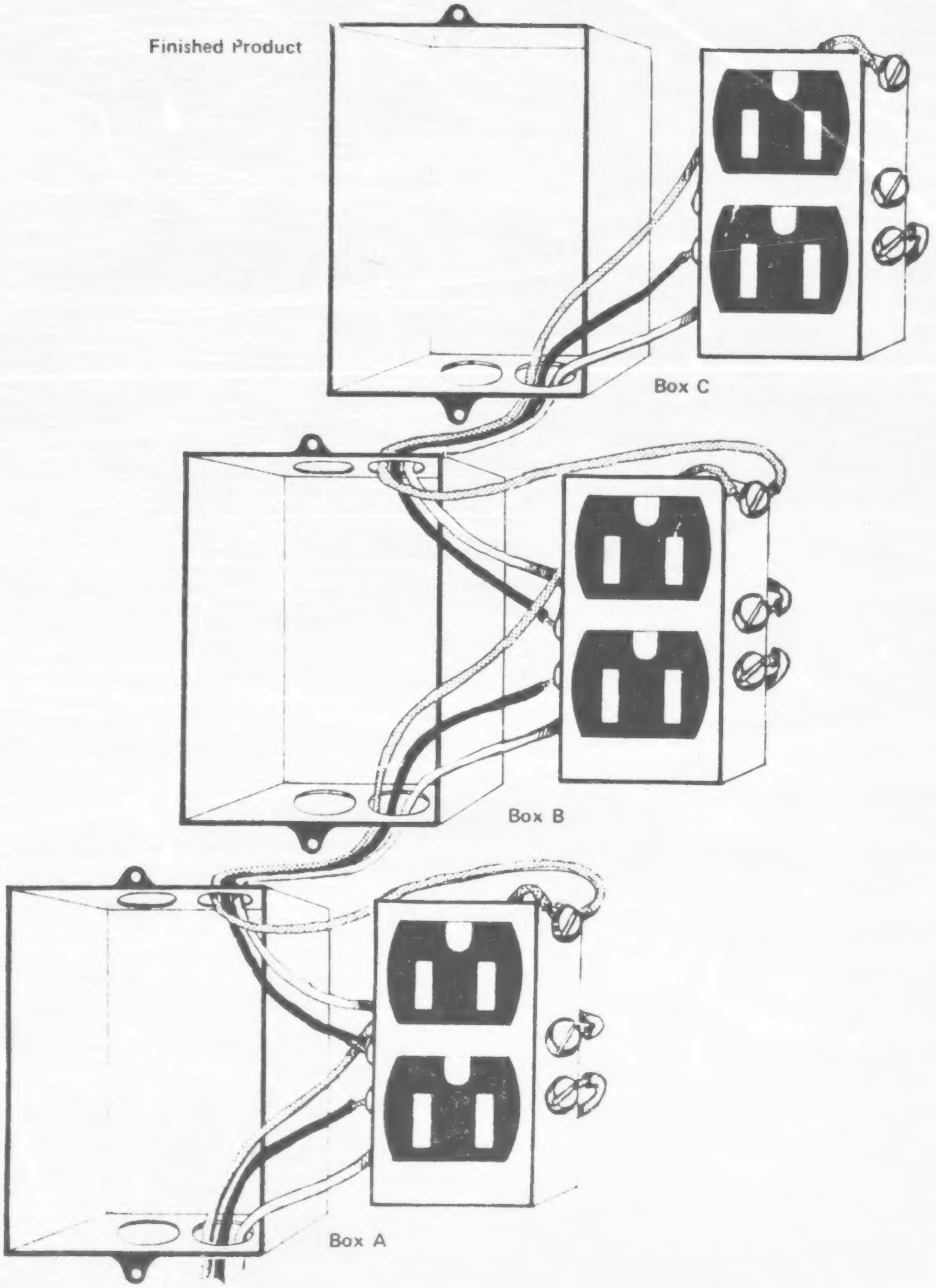

Wrong
Right

Figure E



JOB SHEET #2

IV. Diagram of procedure


Finished Product
Box C
Box B
Box A

ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #3--WIRE A LIGHTING OUTLET CONTROLLED BY TWO THREE-WAY SWITCHES

I. Tools and equipment

   A. Standard screwdriver

   B. Lineman's pliers

   C. Needle-nose pliers

   D. Knife or strippers

II. Materials

   A. Lighting outlet

   B. Octagon box

   C. Two three-way switches and cover plates

   D. Two flush mount wall boxes

   E. Black tape for tracer marking

   F. Two pieces of 12/3 NM cable, two feet long

   (NOTE: In this job, the 12/3 NM cable contains 3 wires; white (the neutral) will be used as a hot carrier and requires a tracer wire marking. The black wire will be the hot wire, and the red wire will be used as a hot carrier wire.)

   G. One piece of 12/2 NM cable, 2 feet long

   H. One piece of 2' x 3' x 1/4" inch plywood

III. Procedure

   A. Attach octagon box and both wall boxes to plywood (Figure A)

   B. Remove approximately five inches of the outside insulation on each end of the NM cable

   C. Remove knock-out plug from wall box and loosen screw in box; place one 12/3 NM cable under plate and allow approximately six inches to extend from box and tighten screw

JOB SHEET #3

(CAUTION: Be careful not to tighten screw too tight because of cutting insulation on wire.)

D. Remove 1 to 1 1/2 inch of insulation from wire

(CAUTION: This should be done in such a manner to not scratch or mark the wire.) (Figure B)

E. Remove knock-out plugs on octagon box located directly across from each other

F. Using the remainder of wire extending from wall-box, run to octagon box and use the same procedure for fastening wire to octagon box as in fastening to wall box

G. Repeat the same procedure with the other 12/3 NM cable connecting the other wall box to the octagon box

(NOTE: While conducting this step, you will need to repeat steps C, D, and F.)

H. Remove five inches of outside insulation from both ends of the 12/2 NM cable

I. Knock out one of the remaining plugs in the octagon box

J. Pull six inches of the cable through the box and secure to clamp; remove one inch of insulation from each wire

(CAUTION: This should be done in such a manner not to scratch or mark the wire.)

(NOTE: The other end of this cable extending from octagon box will be connected to source at completion of job.)

K. In wall box #1, connect black wire to three-way switch on screw C; connect red wire to screw A and white wire with tracer to screw B (Figure C)

L. In wall box #2, connect black wire to the other three-way switch on screw C, the red wire to screw A, and the white wire with tracer to screw B (Figure C)

(NOTE: Wire should be placed around terminals on switch according to the way the screw turns.)

M. Connect the two red wires in the octagon box together using a pigtail splice

JOB SHEET #3

N. Connect the two white wires, with tracers in the octagon box together using a pigtail splice and connecting cap

O. Connect the black wire from the source to the black wire going to switch #1 using a pigtail splice

P. Connect the black wire from switch #2 to the brass screw on the light fixture

Q. Connect the white wire from source to the silver screw on the light fixture

(CAUTION: Check with instructor before performing the next three steps.)

R. Place wires in wall boxes and fasten switches to the boxes; install switch cover plates

S. Place wires in octagon box and fasten light fixture to box

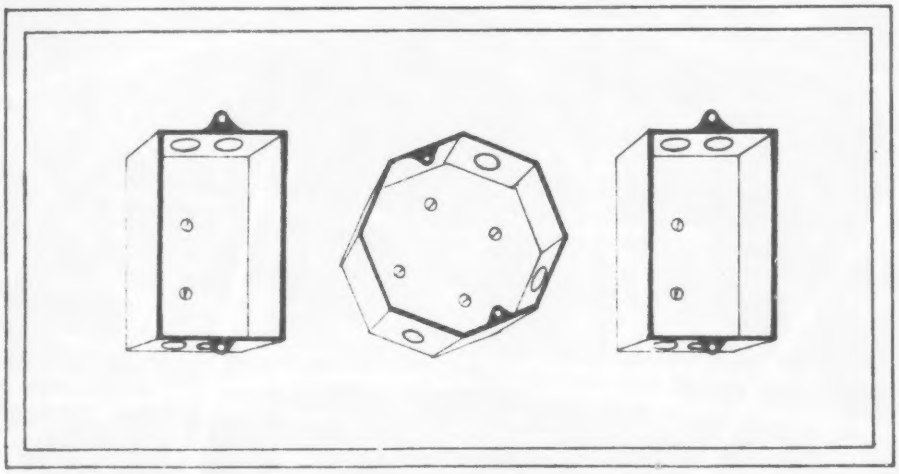
(CAUTION: Do not overtighten fixture.)

T. Connect wire extending from octagon box to source

U. Turn switches off and on to see if job is correct

IV. Diagram of procedure

Figure A



JOB SHEET #3

IV. Diagram of procedure

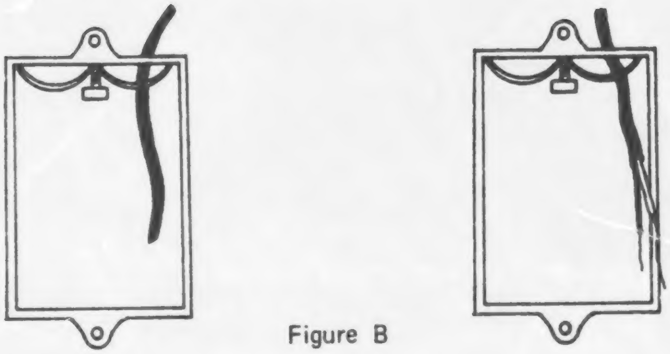
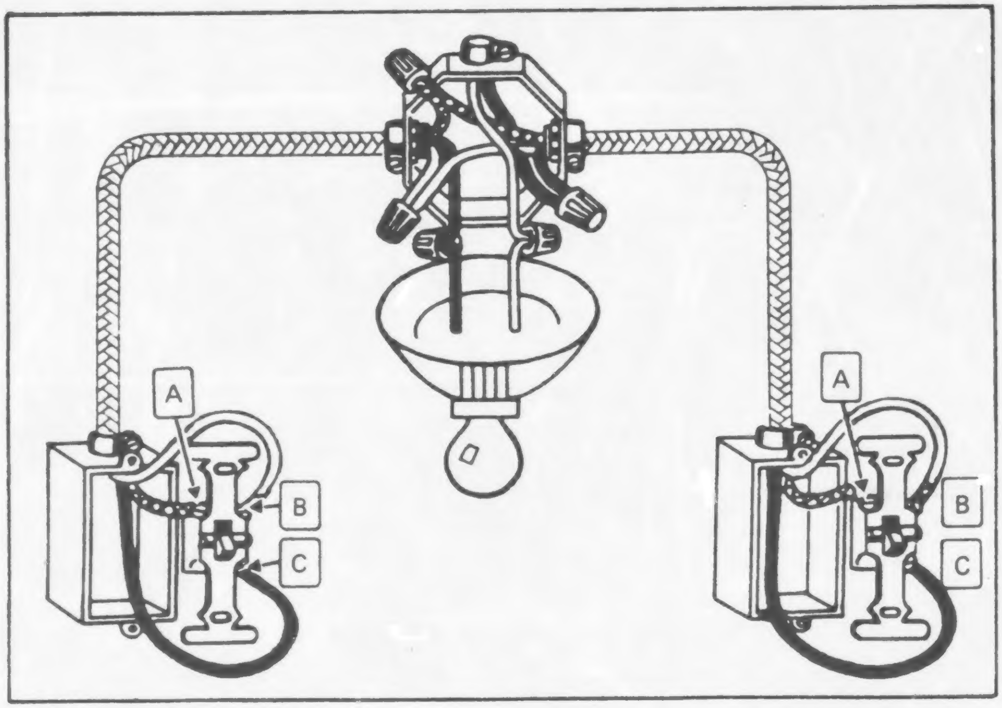


Figure B

Figure C



(NOTE: To simplify this diagram, the grounding wire is not showing, however, cable with the grounding wire must be used in all cases.)

ELECTRICAL WIRING PRACTICES
UNIT III

TEST

1. Define the following terms.

   a. Cable--

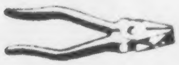
   b. Junction box--

   c. Single-pole toggle switch--

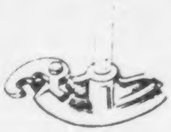
   d. Wire gauge--

   e. Wire size--

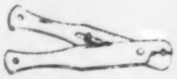
2. Identify the following tools used in electrical wiring.



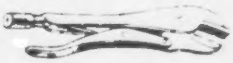
a. __________



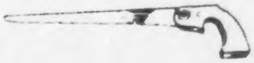
b. __________



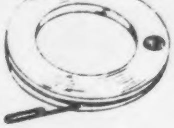
c. __________



d. __________

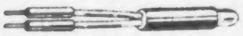


e. __________

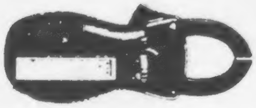


f. __________

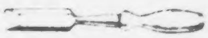
g. __________



h. __________

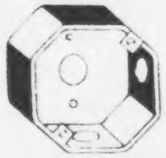


i. __________

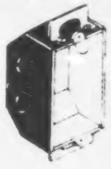


j. __________

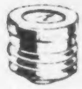
3. Identify the following electrical devices.



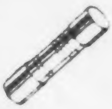
a.____________



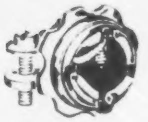
b.____________



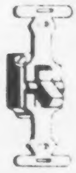
c.____________



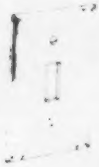
d.____________



e.____________



f.____________



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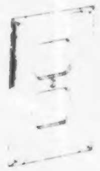

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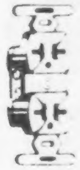
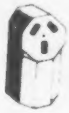


i.____________



j.____________

4. Complete the following chart while identifying electrical conductors.

	ITEM	TYPE	Size AWG	Use
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				

5. Name three factors affecting voltage drop.

   a.

   b.

   c.

6. Name the three-step procedure to follow in wiring.

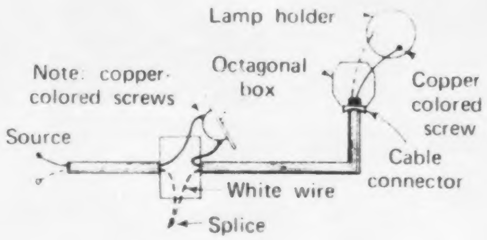
   a.

   b.

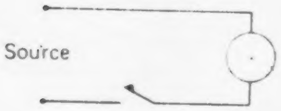
   c.

7. Draw a schematic diagram showing two lights connected in a series and controlled by a switch.

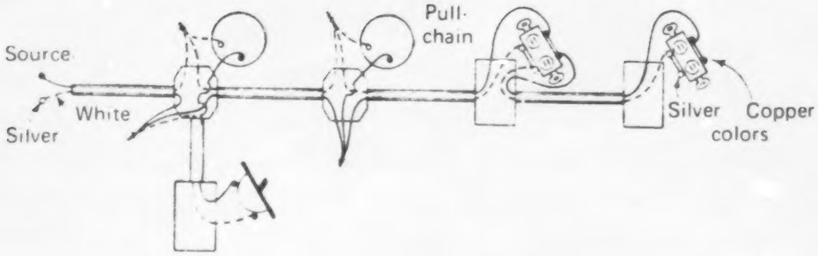
8. Identify the following drawings as either schematic or wiring diagrams.


Lamp holder
Note: copper-colored screws
Octagonal box
Copper colored screw
Source
Cable connector
White wire
Splice

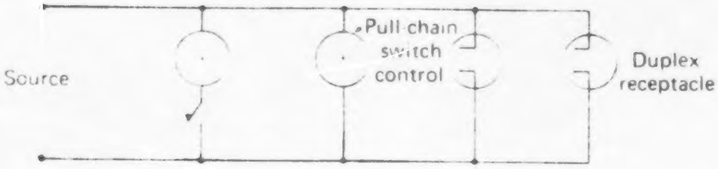
a.____________



b.____________


Source
Silver
White
Pull-chain
Silver
Copper colors

c.____________


Source
Pull chain switch control
Duplex receptacle

d.____________

ELECTRICAL WIRING PRACTICES
UNIT III

ANSWERS TO TEST

1. a. Two or more wires put together inside an overall covering
   b. An outlet box with a blank cover used to contain splices of a circuit
   c. A switch used to break the current in a single place
   d. A tool used to measure wire diameter
   e. The measure of wire diameter
2. a. Lineman's pliers
   b. Conduit bender
   c. Wire cutter, strippers
   d. Vise-grip pliers
   e. Keyhole saw
   f. Fish tape and reel
   g. Hacksaw
   h. Test light
   i. Amp volt meter
   j. Wood chisel
3. a. Octagon box
   b. Flush mount wall box
   c. Singel element fuse, 30-amp, Edison plug type
   d. Time delay fuse, 40-amp, cartridge type
   e. Connector
   f. Toggle wall switch
   g. Cover for toggle wall switch
   h. Cover for duplex receptacle

i. Duplex receptacle

j. 50-amp. 115/230-V., cord receptacle cap

4.

ITEM	TYPE	Size AWG	Use
a.			
b.			
c.			
d.			
e.			
f.			
g.			
h.			
i.			
j.			

5. Any three of the following:
   - a. Length of wire
   - b. Size of wire
   - c. Number of amps flowing through wire
   - d. Type of conductor

6. a. Draw the schematic diagram
   - b. Draw the wiring diagram
   - c. Install wire according to wiring diagram

7. Evaluation will be made by the instructor.

8. a. Wiring
   - b. Schematic
   - c. Wiring
   - d. Schematic

PLANNING THE WIRING LAYOUT
UNIT IV

UNIT OBJECTIVE

After completion of Unit IV, the student should be able to identify electrical symbols used in a wiring diagram and use those symbols in drawing a wiring diagram. The student should be able to figure the number of branch circuits, select service entrance and panel, and determine wire size needed for branch circuits and service entrance switch. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define five terms associated with planning a wiring layout.
2. Identify ten symbols used in a wiring diagram.
3. Name requirements for adequately planning each of the following:
    a. Living room and bedrooms
    b. Dining room, dinette, and breakfast room
    c. Kitchen, kitchenette, and pantry
    d. Laundry room
    e. Bathrooms
    f. Halls
    g. Stairways and closets
    h. Exterior entrances
4. Name the three classifications of branch circuits.
5. Apply the rule for figuring the number of branch circuits required.
6. Apply the rule for selecting the proper service entrance switch.
7. Apply the rule for selecting the proper wire size for branch circuits and service entrance switches.
8. Construct a wiring diagram using the floor plan provided and calculate the total watts required and select the proper service entrance switch.

PLANNING THE WIRING LAYOUT
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and assignment sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Take field trip to observe a wiring layout being installed.

  G. Give test.

II. Students:

  A. Read objectives.

  B. Study information sheets.

  C. Work assignment sheets and turn in to instructor for grading.

  D. Participate in field trip.

  E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheets

  C. Transparency masters

    1. TM 1--Electrical Symbols

    2. TM 2--Branch Circuits

    3. TM 3--Service Entrance Panel

D. Assignment sheets

1. Assignment Sheet No. 1--Determine Branch Circuits, Service Entrance Switches, Wire Sizes for Branch Circuits, and Service Entrance Switch

2. Assignment sheet No. 2--Draw a Wiring Diagram

E. Answers to Assignment Sheet No. 1

F. Test

G. Answers to test

II. References:

A. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook*. Danville, Illinois: The Interstate Printers and Publishers, Inc.

B. Brown, Robert H. *Farm Electrification*. New York: McGraw-Hill Book Company, Inc.

C. "Planning Electrical Outlets," Circular E-719, Earl Lewis, Agricultural Engineering Department, Oklahoma State University, Stillwater, Oklahoma.

D. *Simplified Electric Wiring Handbook*, Sears-Roebuck and Company, Chicago, Illinois.

E. *Understanding Electricity and Electrical Terms*. American Association for Vocational Instructional Materials, Athens, Georgia, 1974. (Purchase from Department of Agricultural Engineering, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska 68583.)

PLANNING THE WIRING LAYOUT
UNIT IV

INFORMATION SHEET

I. Terms and definitions

  A. Service entrance switch--A switch which connects the entire wiring system in a building from the source of meter supply

  B. Wiring plan--A sketch of the house floor plan showing light switches and outlet locations

  C. Branch circuit--The portion of electric conductors that extends from the service entrance switch to a certain group of outlets or to a single outlet

  D. Special purpose outlet--Any electrical appliance which requires an input voltage of 230 volts and any electrical motor having a horsepower rating greater than 1/3 horsepower

II. Symbols used in wiring diagram (Transparency 1)

  A. Lighting outlet

  B. Ceiling lighting outlet for recessed fixture (Outline shows shape of fixture)

  C. Continuous wireway for flourescent lighting on ceilings, in coves, cornices, etc. (Extend rectangle to show length of installation.)

  D. Duplex convenience outlet

  E. Duplex convenience outlet--split wired

  F. Duplex convenience outlet for grounding

  G. Weatherproof duplex convenience outlet

  H. Floor outlet

  I. Special-purpose outlet (Use subscript letters to indicate function: DW-Dishwasher, CD-Clothes Dryer, etc.)

  J. Single-pole switch

  K. Three-way switch

  L. Four-way switch

INFORMATION SHEET

M. Switch and pilot or indicator light

N. Weatherproof switch

O. Television outlet

III. Planning the convenience outlets

A. Living room and bedrooms

1. One or more ceiling lights controlled by wall switch
2. Duplex outlets spaced 12 feet apart around wall so no point is over 6 feet away from outlet

B. Dining room, dinette, breakfast room

1. One or more ceiling light controlled by wall switch
2. Duplex outlets spaced 12 feet apart around wall so no point is over 6 feet away from outlet

C. Kitchen, kitchenette, pantry

1. One or more ceiling light, controlled by wall switch
2. One ceiling light or wall light located over sink, wall controlled
3. Special purpose outlets for range, dishwasher, disposal, and as needed on items over 1/3 hp.
4. Duplex outlets spaced every four feet of kitchen work surface
5. At least one duplex outlet for each usuable wall space not previously used

(NOTE: Use 6 by 12 feet rule.)

D. Laundry and utility room

1. One or more ceiling outlet controlled by wall switch
2. Duplex outlets located for miscellaneous uses

(NOTE: Three-prong grounding outlets are required.)

3. Special purpose outlets for dryer, water heater, and furnace

INFORMATION SHEET

E. Bathrooms

1. One or more lighting outlet located at mirror, controlled by wall switch
2. Duplex outlet required near mirror

F. Halls

1. One ceiling outlet, controlled by S3 wall switch

   (NOTE: If hall is L shaped, an additional ceiling outlet is required.)

2. One duplex outlet needed for each 12 feet of hall space

G. Stairways and closets

1. One lighting outlet for each floor, controlled by S2 wall switch
2. One lighting outlet for each closet, controlled by wall switch

H. Exterior entrances

1. One lighting outlet at back and front of house, controlled by indoor wall switch
2. One single weatherproof outlet located at front and one at back of house

IV. Classification of branch circuits

A. 20-amp--general purpose

B. 20-amp--small appliance

C. 50-amp--special purpose individual outlet

V. Branch circuit requirements (Transparency 2)

A. 20-amp general purpose

1. One branch circuit for each 500 square feet of floor space
2. Nine outlets per general purpose circuit

   (NOTE: This is according to the N.E.C.)

INFORMATION SHEET

3. Add total number of outlets, divide by 9, count any fraction as a whole

   (NOTE: Do not count receptacles in the laundry room, kitchen, dining room, pantry, and breakfast room.)

B. 20-amp small appliance

   1. Three circuits per house
   2. Three outlets per small appliance circuit
   3. Located in kitchen, laundry room, pantry, dining room, breakfast room
   4. Add number of outlets, divide by three, count any fraction as a whole

C. Individual equipment (Special purpose)

   1. One branch circuit for each special outlet
   2. Motors of 1/3 horsepower and larger

D. Example of calculations

   1. 20-amp circuits (7 circuits)

First 2	2 x 1,700 = 3,400	3,400
Others 5	5 x 600 = 3,000	3,000

   2. Range 16,000 watts

Count first 8,000 watts	8,000
16,000 - 12,000 = 4,000 in excess of 12,000	
4 x 400 =	1,600

   3. Other individual circuits

Water heater 4,500 watts full value	4,500
Home freezer 1/2 hp x 1000 = 500	500
Dishwasher 1/4 hp x 1200 = 300	300
Furnace 1/3 hp x 1200 = 400	400
Washing machine 1/3 hp x 1200 = 400	400
Dryer 6,000 watts full value	6,000
	28,100

28,100 ÷ 230 = 122 amp

INFORMATION SHEET

VI. Selecting service entrance switch (Transparency 3)

A. Minimum size allowed 100-amp

B. Add wattage, divide by 230 volts, equals amps

C. Standard sizes: 100, 125, 150, and 200 amps

VII. Selecting proper wire size

A. Range from 40 to 0000 AWG

B. Table showing related sizes of wires

Wire size AWG Number	Wire rating amp
14	15
12	20
10	30
8	40
6	55
4	70
3	80
2	95
1	110
1/0	125
2/0	145
3/0	165
4/0	195

C. Branch circuit wires

	Ampere or wattage rating	Wire size, AWG	Wire rating, amp	Maximum device, amp
Branch circuit:				
20-amp general and small appliance	20 amp	12	20	20
Individual range	16,000 watts	6	50	50 or 60
Individual water heater	4,500 watts	10	30	30
Individual freezer	200 watts	12	20	20
Individual washing machine	400 watts	12	20	20

INFORMATION SHEET

Service entrance cable:

For a 30-amp service entrance switch	8	40	30
For a 60-amp service entrance switch	6	50	60
For a 70-amp service entrance switch	4	70	70
For a 100-amp service entrance switch	2	95	100
For a 125-amp service entrance switch	1/0	125	125
For a 150-amp service entrance switch	2/0	150	150
For a 200-amp service entrance switch	4/0	195	195

(NOTE: Over 100-amp, use conduit and appropriate wire and fuses.)

VIII. Wiring floor plan

A. Circuits

1.	Dryer	240 volts	25.0 amps	10/3 wire
2.	Hot water heater	240 volts	19.0 amps	10/2 g wire
3.	Electric range	240 volts	50.0 amps	6/3 wire
4.	Washing machine	120 volts	2.2 amps	12/2 g wire
5.	Furnace	120 volts	3.3 amps	12/2 g wire
6.	Freezer	120 volts	3.3 amps	12/2 g wire
7.	Small appliance			
8.	Small appliance			
9.	General purpose			
10.	General purpose			
11.	General purpose			
12.	General purpose			

(NOTE: For each 240-volt outlet add one additional circuit.)

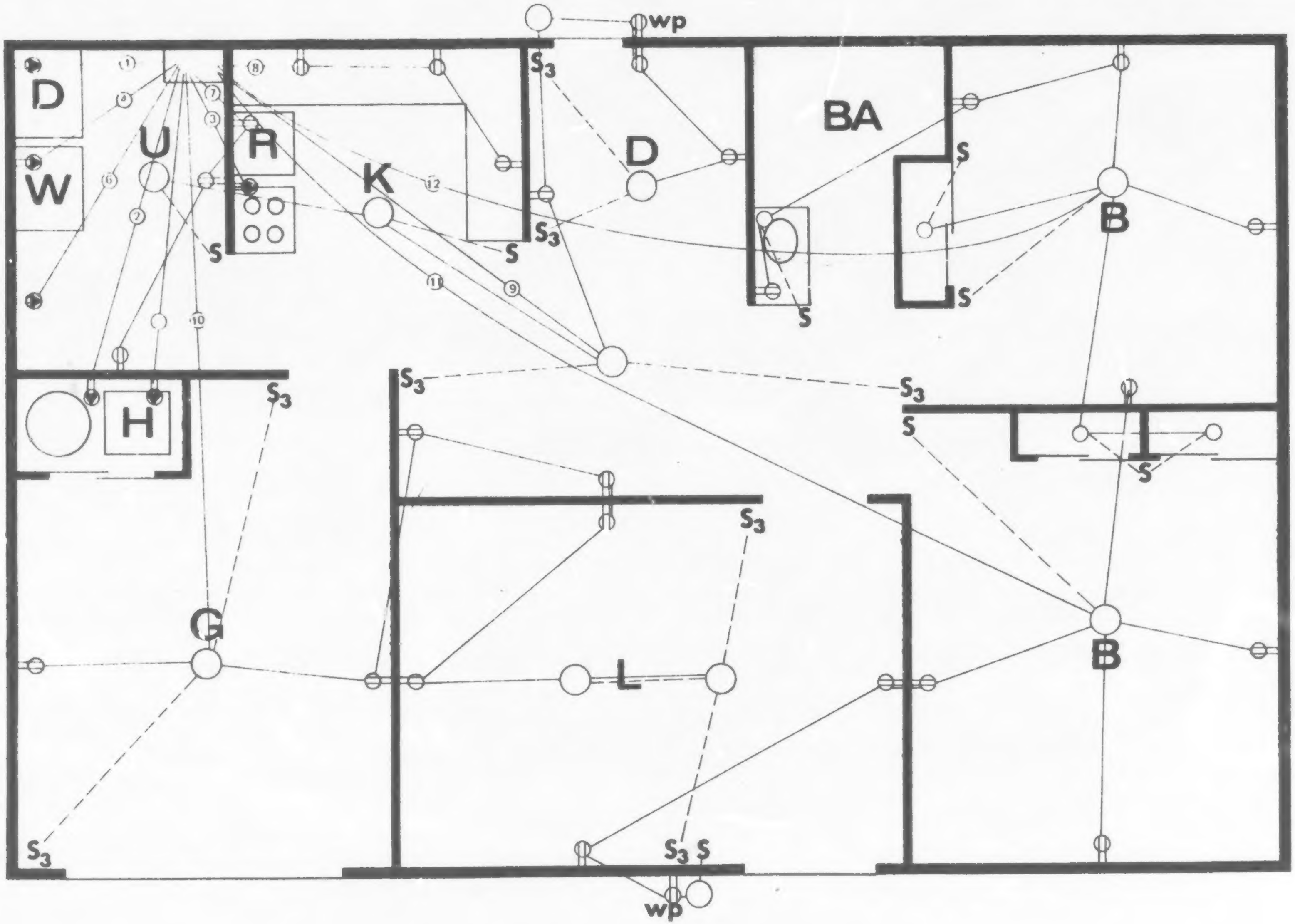
INFORMATION SHEET

B. Example of calculations

1.	20-amp circuits (6 circuits)	
	First 2 2x1,700 = 3,400	3,400
	Others 4 4x600 = 2,400	2,400
2.	Range 16,000 watts	
	Count first 8,000 watts	8,000
	16,000 - 12,000 = 4,000 in excess of 12,000	
	4 x 400	1,600
3.	Special purpose circuits	
	Dryer 6,000 watts take at full value	6,000
	Water heater 4,500 watts take at full value	4,500
	Freezer 1/2 hp x 1000 = 500	500
	Furnace 1/3 hp x 1200 = 400	400
	Washing machine 1/3 hp x 1200 = 400	400
		27,200

27,200 ÷ 240 = 113

(NOTE: Requires a 125-amp service entrance switch.)


wp
D
S_3
D
BA
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S_3
S_3
H
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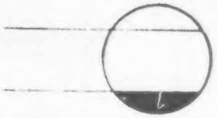
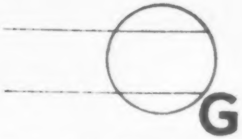
11
12

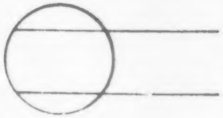
Electrical Symbols



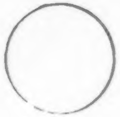
Duplex Convenience Outlet-Split Wired



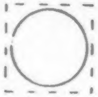
Duplex Grounding Outlet



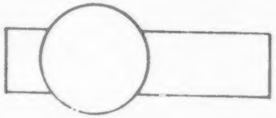
Duplex Convenience Outlet



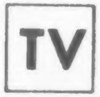
Lighting Outlet



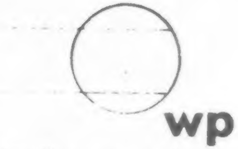
Ceiling Lighting Outlet



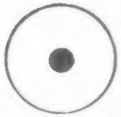
Fluorescent Lighting



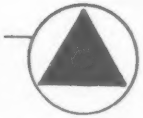
Television Outlet



Weatherproof Duplex Outlet



Floor Outlet



Special-Purpose Outlet

S

Single-Pole Switch

S_3

Three-Way Switch

S_4

Four-Way Switch

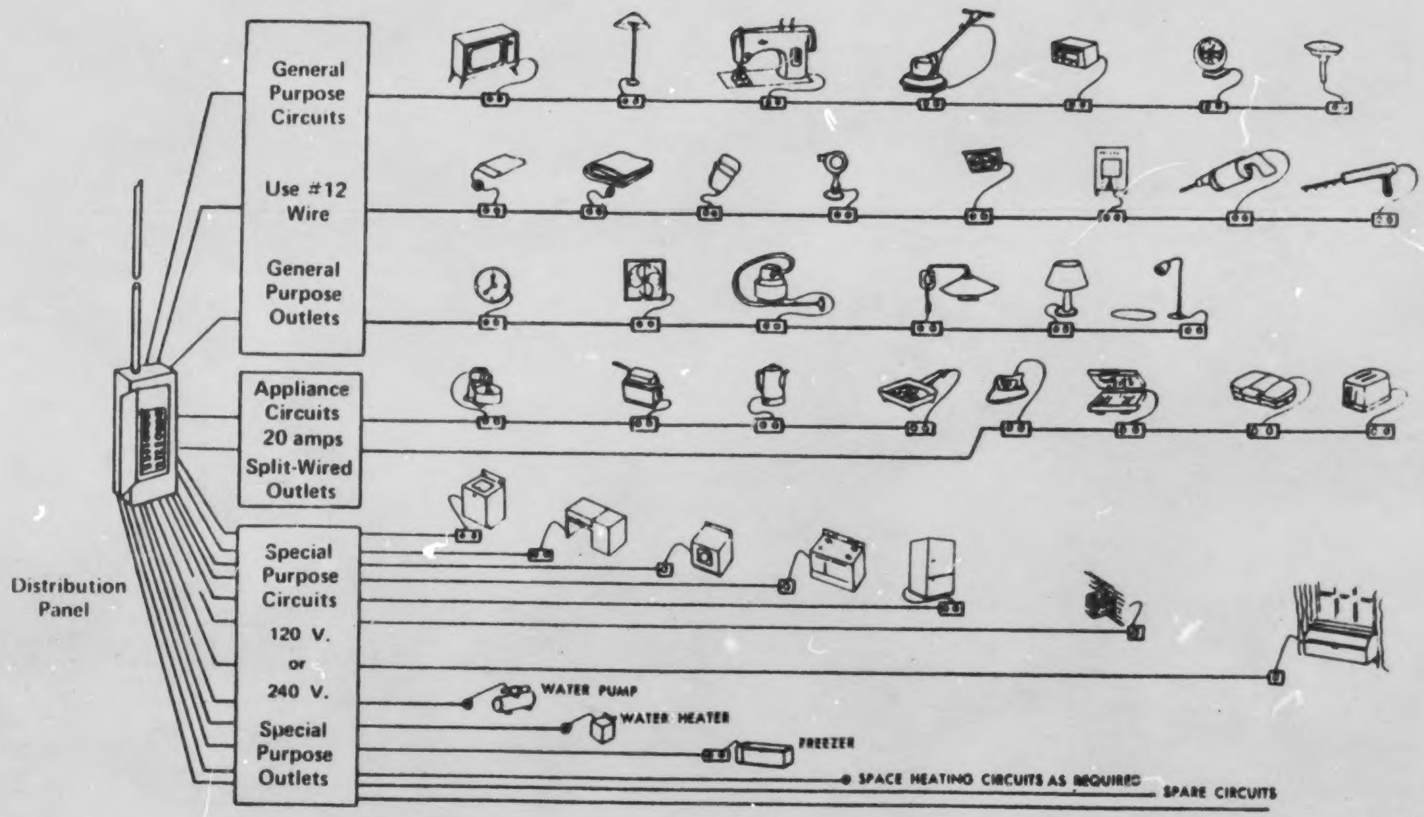
S_p

Switch and Pilot

S_w

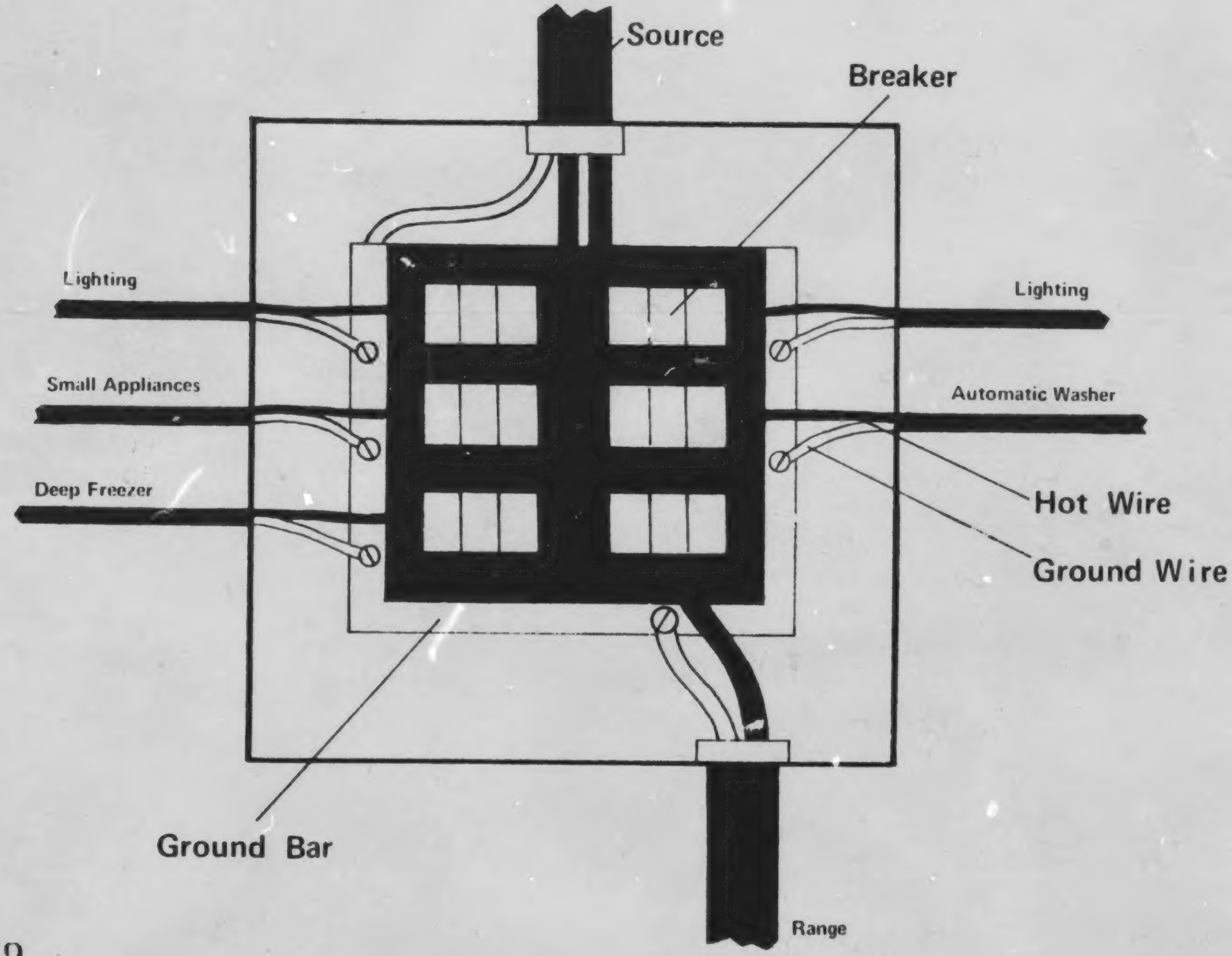
Weatherproof Switch

Branch Circuits



General Purpose Circuits
Use #12 Wire
General Purpose Outlets
Appliance Circuits 20 amps
Split-Wired Outlets
Special Purpose Circuits
120 V. or 240 V.
Special Purpose Outlets
Distribution Panel
WATER PUMP
WATER HEATER
FREEZER
SPACE HEATING CIRCUITS AS REQUIRED
SPARE CIRCUITS

Service Entrance Panel


Source
Breaker
Lighting
Lighting
Small Appliances
Automatic Washer
Deep Freezer
Hot Wire
Ground Wire
Ground Bar
Range

PLANNING THE WIRING LAYOUT
UNIT IV

ASSIGNMENT SHEET NO. 1--DETERMINE BRANCH CIRCUITS, SERVICE ENTRANCE SWITCH, AND WIRE SIZES FOR BRANCH CIRCUITS AND SERVICE ENTRANCE SWITCH

The following data was obtained after planning the type and location of outlets for a new residence.

18 - 20 amp general and lighting outlets
6 - 20 amp small appliance outlets
1 - Water heater 4,500 watts
1 - Freezer 1/3 hp. motor
1 - Range 16,000 watts
1 - Dishwasher 1/3 hp. motor
1 - Dryer 6,000 watts

Using the information above complete the following questions.

A. What is the number of branch circuits required?

B. What size wire should be used for each branch circuit?

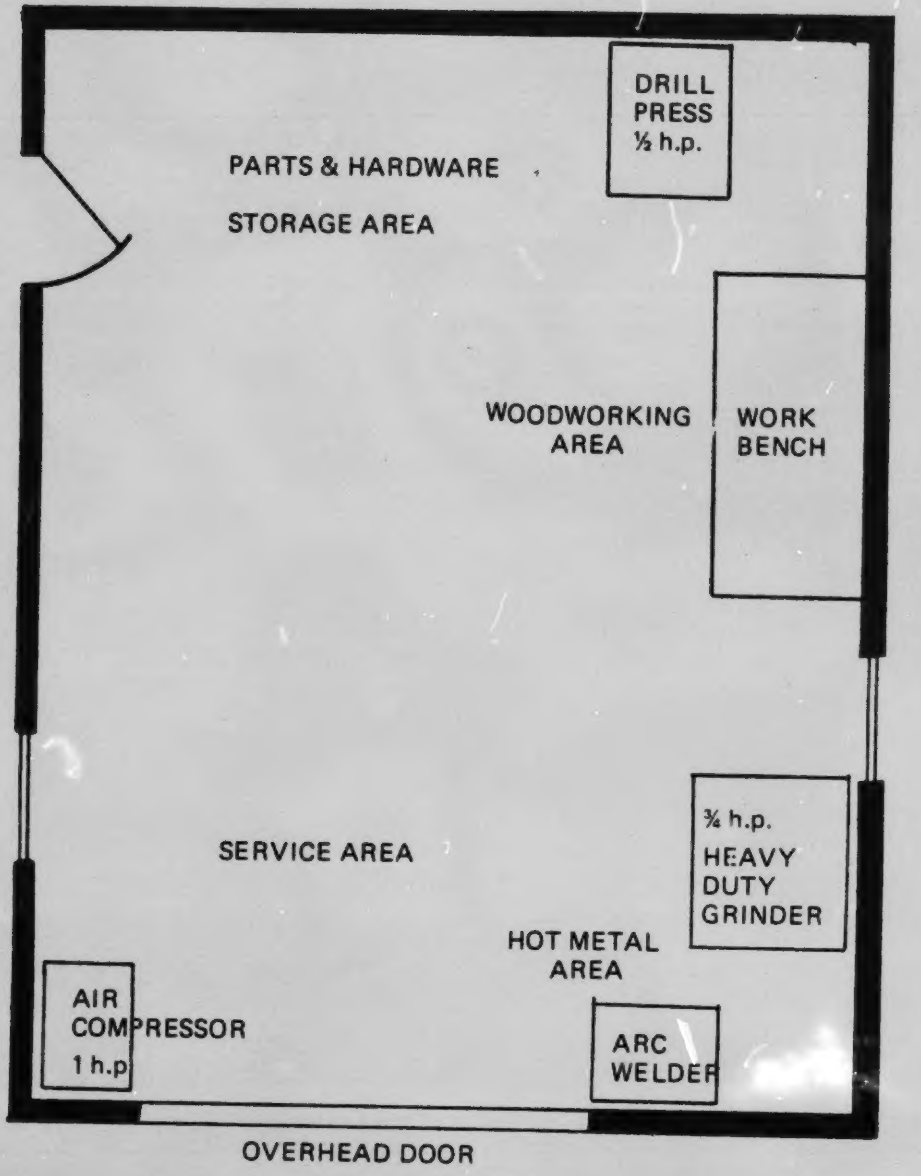
C. What size service entrance switch should be used?

D. What size wire should be used for the service entrance switch?

PLANNING THE WIRING LAYOUT
UNIT IV

ASSIGNMENT SHEET NO. 2--DRAW A WIRING DIAGRAM

Draw a wiring diagram using the floor plan below. When finished with the drawing, calculate the number of branch circuits required, size of service entrance switch needed, and determine size of wire to use for each branch circuit and service entrance wire.


DRILL PRESS ½ h.p.
PARTS & HARDWARE
STORAGE AREA
WOODWORKING AREA
WORK BENCH
¾ h.p. HEAVY DUTY GRINDER
SERVICE AREA
HOT METAL AREA
AIR COMPRESSOR 1 h.p
ARC WELDER
OVERHEAD DOOR

PLANNING THE WIRING LAYOUT
UNIT IV

ANSWERS TO ASSIGNMENT SHEET #1

A. 18 General and lighting outlets

18 ÷ 9 = 2 circuits

6 small appliances ÷ 3 = 2 circuits

2 extra circuits needed because of two 240-volt outlets

4 + 2 = 6 Circuits

B.

General purpose outlets	12/2 g AWG
Small appliance	12/2 g AWG
Range	6/3 AWG
Water heater	10/2 g AWG
Freezer	12/2 g AWG
Dryer	10/3 AWG

C.

20-amp circuits (4 circuits)	
First two 2 x 1,700 = 3,400	3,400
Others 2 x 600 = 1,200	1,200
Range 16,000 watts	
Count first 8,000	8,000
16,000-12,000 = 4,000 in excess of 12,000 4 x 400 = 1,600	1,600
Special individual circuits	
Water heater	4,500
Freezer 1/6 hp. x 1,200 = 200	200
Dryer 6,000 watts	6,000
Dishwasher 1/3 hp. x 1,200 = 400	400
	25,300 watts

25,300 ÷ 240 = 105 amps

(NOTE: Use 125-amp service entrance switch.)

D. Use No. 1/0 AWG wire

PLANNING THE WIRING LAYOUT
UNIT IV

TEST

1. Define the following terms.

   a. Special purpose outlet--

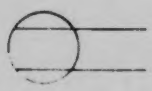
   b. Wiring plan--

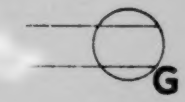
   c. Branch circuits--

   d. Service entrance switch--

   e. AWG--

2. Identify the following electrical symbols.





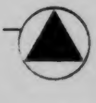
S_3

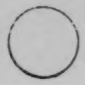
a. ______________

b. ______________

c. ______________

S

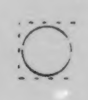


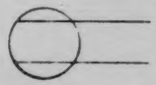


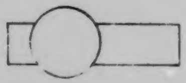
d. ______________

e. ______________

f. ______________



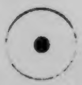




g. ______________

h. ______________

i. ______________



j. ______________

3. How many ceiling lights should be in the living room or bedroom according to the NEC? ____________

4. How far apart should the duplex receptacles be spaced? ____________

5. How should the ceiling lights be controlled in the dining room? ____________

6. What type of outlet is required for the range and dishwasher? ____________

7. Does the NEC require a light placed over the sink? ____________

8. Name the requirements for adequately wiring the laundry room.

   a.

   b.

   c.

9. How many duplex receptacles are needed in a hallway? ____________

10. Does the NEC require lights to be installed in all closets? ________

11. Name the requirements for adequately wiring the exterior entrances.

    a.

    b.

12. Name the three classifications of branch circuits.

    a.

    b.

    c.

13. How many branch circuits would be necessary to install 15 general purpose outlets, 8 small appliance outlets, and 5 special purpose outlets? ____________

14. What size service entrance switch would be necessary if the total wattage is 12,000 watts and you have a 240-volt service? ____________

PLANNING THE WIRING LAYOUT
UNIT IV

ANSWERS TO TEST

1. a. Any electrical appliance which requires an input voltage of 230 watts and any electrical motor having a horsepower rating greater than 1/3 hp.
   b. A sketch of the house floor plan showing light switches and outlet locations
   c. The portion of electric conductors that extends from the service entrance switch to a certain group of outlets or to a single outlet
   d. A switch which connects the entire wiring system in a building to the source of supply
   e. American Wire Gauge--Standard wire measurement
2. a. Duplex convenience outlet
   b. Duplex grounding outlet
   c. Three-way switch
   d. Single-pole switch
   e. Special purpose outlet
   f. Lighting outlet
   g. Ceiling lighting outlet for recessed fixture
   h. Duplex convenience outlet
   i. Fluorescent lighting outlet
   j. Floor outlet
3. One
4. Six feet
5. Controlled by wall switch
6. Special purpose
7. Yes
8. a. One ceiling outlet, controlled by wall switch
   b. Duplex outlets located for miscellaneous uses

c. Special purpose outlets for dryer

9. One for each 15 feet of space

10. Yes

11. a. One lighting outlet, controlled by wall switch
    b. One single weatherproof outlet located at front and one at back of house

12. a. 20-amp--General purpose
    b. 20-amp--Small appliance
    c. 30-50-amp--Individual equipment

13. 10 branch circuits required

14. 50-amp service entrance switch

ENGINE OPERATION—PART I
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to define terms associated with small engines. The student should be able to identify operating positions, valve parts, and valve failures and describe the operation and use of small engines. The student should be able to disassemble and reassemble a small gasoline engine. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define five terms associated with small gasoline engine repair.
2. Name five machines that are powered by a small gasoline engine.
3. Identify the three basic operating positions on small gasoline engines.
4. Distinguish between a two-stroke cycle engine and a four-stroke cycle engine.
5. Name and describe the four principal events in the operation of a four-cycle engine.
6. Name three advantages of an air-cooled engine.
7. Name the simple rule for testing compression.
8. Identify the parts of a valve when given a drawing illustrating the parts.
9. Identify three types of valve failure when given a drawing showing each type.
10. Complete an engine inspection chart.
11. Demonstrate the ability to:
    a. Disassemble a small gasoline engine.
    b. Reassemble a small gasoline engine.

ENGINE OPERATION—PART I
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information, job, and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Give test.

II. Students:

   A. Read objectives.

   B. Study information sheets.

   C. Complete assignment sheet and turn in to instructor.

   D. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheets

   C. Transparency masters

      1. TM 1--Engine Operating Positions

      2. TM 2--Principal Events in the Operating Cycle of an Engine

   3. TM 3--Valve Parts

   4. TM 4--Types of Valve Failures

D. Assignment Sheet No. 1--Engine Inspection Chart

E. Job sheets

   1. Job Sheet No. 1--Disassemble A Small Gasoline Engine

   2. Job Sheet No. 2--Reassemble a Small Gasoline Engine

F. Test

G. Answers to test

II. References:

A. *Small Engines Care, Operation, Maintenance, and Repair*, Volume I, American Association for Vocational Instructional Materials. (Purchase from Agriculture Engineering Department, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska 68583.)

B. *Briggs and Stratton Repair Instructions III*, Briggs and Stratton Corporation, Milwaukee, Wisconsin.

C. *General Theories of Operation*, Briggs and Stratton Corporation, Milwaukee, Wisconsin.

D. *Small Gasoline Engines Student Handbook*, Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

ENGINE OPERATION—PART I
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Camshaft--The shaft containing lobes or cams to operate the engine valves

B. Carburetor--A device for automatically mixing fuel in the proper proportion with air to produce a combustible gas

C. Combustion--The process of burning

D. Combustion chamber--The volume of the cylinder above the piston with the piston on top center

E. Compression--The reduction in volume or the squeezing of a gas

F. Condenser--A device for temporarily collecting and storing a surge or electrical current for later discharge

G. Conductor--A material along or through which electricity will flow with a slight resistance

H. Connecting rod--A rod that connects the piston to the crankshaft

I. Crankcase--The housing in which the crankshaft and many other parts of the engine operate

J. Crankshaft--The main shaft of the engine which, in conjunction with the connecting rods, changes the reciprocating motion of the pistons into rotary motion

K. Cylinder--A round hole having some depth bored to receive a piston also sometimes referred to as *bore* or *barrel*

L. Cylinder block--The largest single part of an engine; the basis or main mass of metal in which the cylinders are bored or placed

M. Cylinder head--A detachable portion of an engine fastened securely to the cylinder block which contains all or a portion of the combustion chamber

N. Exhaust pipe--The pipe connecting the engine to the muffler to conduct the exhausted gases away from the engine

O. Gasket--Anything used as a packing, such as a non-metallic substance, placed between two metal surfaces to act as a seal

INFORMATION SHEET

P. Governor--A device consisting of control which is used to regulate engine speed

Q. Ignition system--The means for igniting the fuel in the cylinder including spark plugs, wiring, ignition, distributor ignition coil; source of electrical supply

R. Intake valve--A valve which permits a fluid or gas to enter the chamber and seals the exit

S. Piston--A cylindrical part closed at one end which is connected to the crankshaft by the connecting rod

T. Piston head--The part of the piston above the rings

U. Piston pin--The journal for the bearing in the small end of an engine connecting rod which also passes through piston walls; also known as a wrist pin

V. Piston ring--An expanding ring placed in the grooves of the piston to provide a seal to prevent the passage of fluid or gas past the piston

W. Score--A scratch, ridge, or groove marring a finished surface

X. Spark--An electrical current possessing sufficient pressure to jump through the air from one conductor to another

Y. Spark gap--The space between the electrodes of a spark plug through which the spark jumps

Z. Spark plug--A device inserted into the combustion chamber of an engine containing an insulated control electrode for conducting current

AA. Stroke--The distance moved by the piston

BB. Valve--A device for opening and closing the openings that admit the air and gas mixture into the cylinder

CC. Vapor lock--A condition whereby the fuel boils in the fuel system forming bubbles which retard or stop the flow of fuel to the carburetor

DD. Venturi--Is the necked or reduced area in the carburetor producing the Bernoulli effect.

EE. Bernoulli effect--As the speed of a fluid (gas or liquid) increases, there is a decrease in pressure and, conversely, where there is a decrease in velocity of the fluid, the pressure increases.

II. Machines powered by small engine

A. Motorcycles

B. Chain saws

C. Mowers

INFORMATION SHEET

- D. Outboard motors
- E. Pumps
- F. Posthole diggers
- G. Elevators

III. Operating positions (Transparency 1)

- A. Vertical
- B. Horizontal
- C. Multi-position

IV. Events of a 4-cycle engine (Transparency 2)

- A. Intake stroke
    1. Exhaust valve is closed
    2. Intake valve is open
    3. The piston moves downward and the air-fuel mixture is drawn into the cylinder
- B. Compression
    1. Intake valve closes
    2. Piston moves upward
    3. The air-fuel mixture is compressed
- C. Power
    1. Spark occurs, igniting the mixture
    2. Forces of expanding gases push the piston down
- D Exhaust
    1. Exhaust valve opens
    2. Upward movement of piston forces the burned gases out of the cylinder
    3. Exhaust valve closes

INFORMATION SHEET

   4. Cycle is repeated

V. Engines

   A. 4-cycle

      1. Two revolutions of crankshaft per firing

      2. Lubricated from crankcase oil in the sump

   B. 2-cycle

      1. One revolution of crankshaft per firing

      2. Lubricated from oil mixed with the gasoline

VI. Advantages of air-cooled engines

   A. No need for complicated cooling system

   B. Lighter in weight and occupies less space

   C. Easy to repair

VII. Testing compression--Give the flywheel a quick spin and if it rebounds on the compression stroke, the compression is at least good enough to start the engine

VIII. Parts of a valve (Transparency 3)

   A. Head

   B. Margin

   C. Seat

   D. Face

   E. Stem

   F. Valve guide

IX. Valve failures (Transparency 4)

   A. Burned

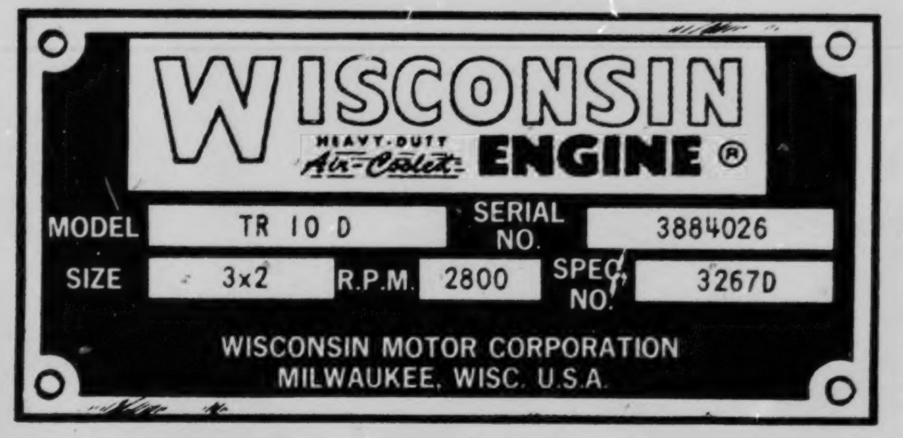
   B. Necked

   C. Dished

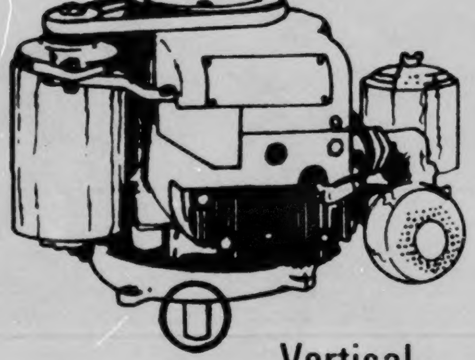
INFORMATION SHEET

X. Information found on name plate

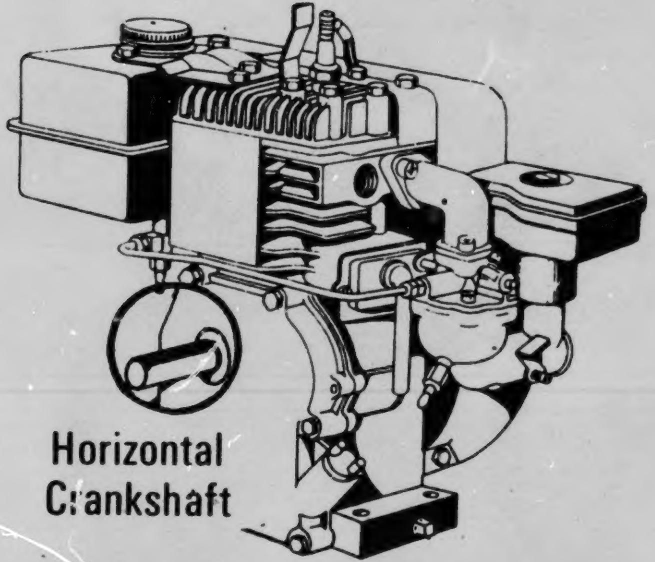
- A. Make of engine
- B. Model number
- C. Serial number
- D. Specification number
- E. Size
- F. RPM


WISCONSIN
HEAVY-DUTY
Air-Cooled
ENGINE ®
MODEL
TR 10 D
SERIAL NO.
3884026
SIZE
3x2
R.P.M.
2800
SPEC. NO.
3267D
WISCONSIN MOTOR CORPORATION
MILWAUKEE, WISC. U.S.A.

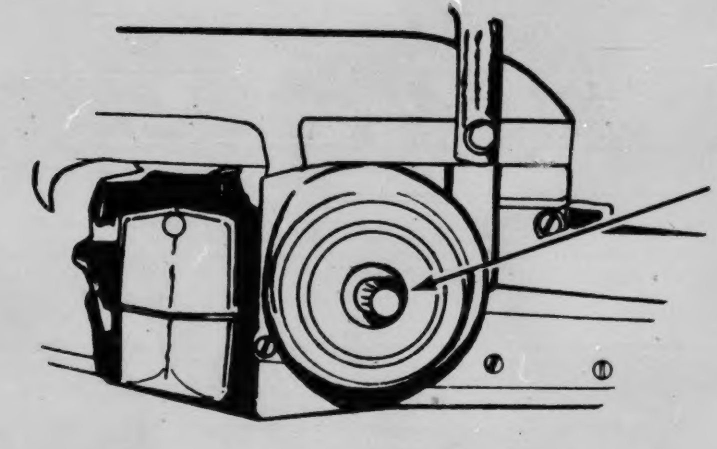
Engine Operating Positions



Vertical Crankshaft

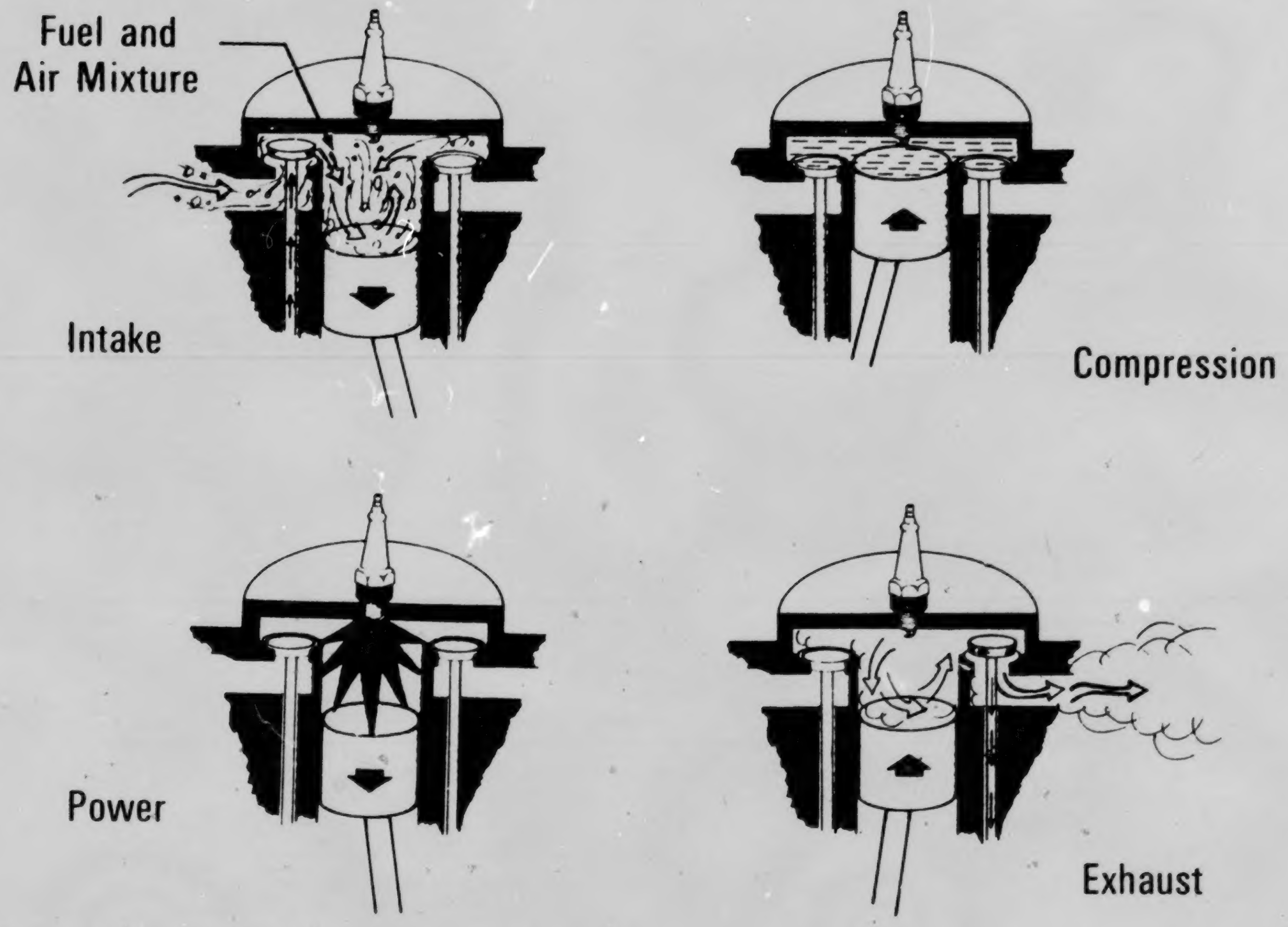


Horizontal Crankshaft

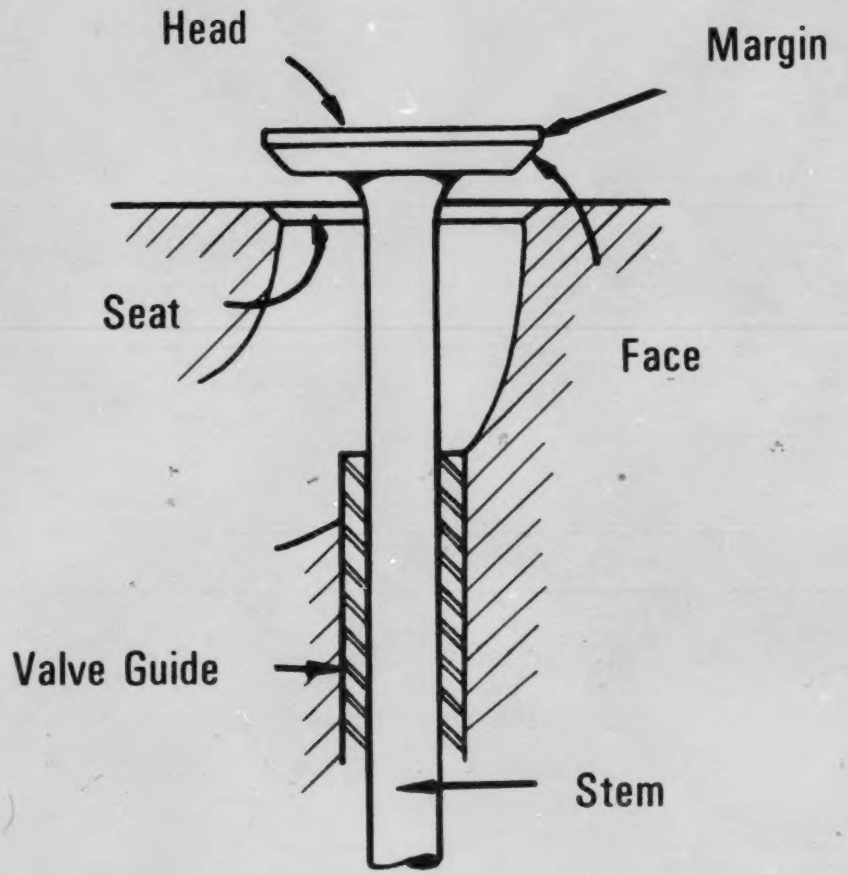


Multi-Position Crankshaft

Principal Events in the Operating Cycle of an Engine


Fuel and Air Mixture
Intake
Compression
Power
Exhaust

Valve Parts

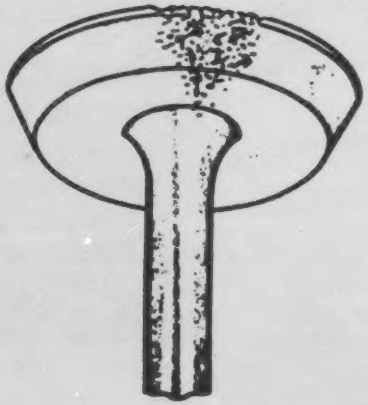

Head
Margin
Seat
Face
Valve Guide
Stem

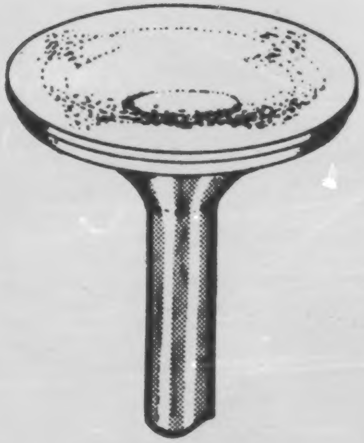
TM 3

AM-157-B

Types of Valve Failures

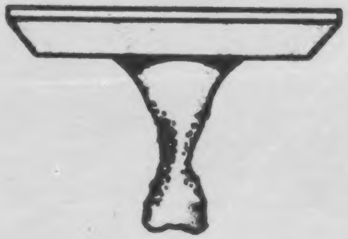
Burned





Dished

Necked



TM 4

AM-159-B

AM-161-B

ENGINE OPERATION—PART I
UNIT V

ASSIGNMENT SHEET NO. 1–ENGINE INSPECTION CHART

Using an engine, designated by your instructor, complete the following inspection chart.

Engine: Make ____________________ Model ____________ Serial No. ____________

Specification Number __________________ Horsepower ______________

Operating Position of Crankshaft: Vertical ___ , Horizontal ___ , Multi-Position _____ .

Engine Cycle: 2-Cycle ___ , 4-Cycle ___ .

TYPES OF ACCESSORIES AND MAJOR UNITS:

CARBURETOR AIR CLEANER: Oil bath ☐ , Oiled filter ☐ , Dry filter ☐ .

FUEL STRAINER: Combination screen and sediment bowl ☐, Screen inside the fuel tank ☐ .

CRANKCASE BREATHER: Reed valve ☐ , Floating disk valve ☐ .

STARTER: Rope-wind ☐ , Rope-rewind ☐ , Wind up ☐ ,
Electric, AC ☐ , Electric, DC ☐ .

IGNITION SYSTEM: Flywheel magneto ☐ , External magnet ☐ , Battery ☐ .

FUEL PUMP: Mechanically driven ☐ , Differential pressure driven ☐ .

CARBURETOR: Float ☐ , Suction lift ☐ , Diaphragm ☐ .

GOVERNOR: Air vane ☐ , Centrifugal ☐ .

ENGINE OPERATION—PART I
UNIT V

JOB SHEET #1--DISASSEMBLE A SMALL GASOLINE ENGINE

I. Tools and materials needed

   A. 4-cycle engine
   B. 3/8" drive socket set
   C. Combination wrench set
   D. Standard screwdriver
   E. Soft mallet
   F. Adjustable wrench
   G. Punches
   H. Ring compressor
   I. Flywheel puller
   J. Starter wrench
   K. Flywheel holder
   L. Spring compressor
   M. Container for holding parts

II. Procedure

   A. Drain oil
   B. Remove air cleaner stud and wing nut
   C. Remove fuel line
   D. Remove carburetor and linkage
   E. Remove carburetor intake elbow
   F. Remove muffler if necessary
   G. Check space between carburetor bodies on two-piece carburetor
   H. Remove shroud and check rewind starter

JOB SHEET #1

I. Check compression

J. Remove spark plug

K. Check air gap, armature to flywheel

L. Remove governor blade

M. Remove breather assembly

N. Remove cylinder head and shield

O. Check tappet clearance

P. Remove valves and springs

Q. Remove starter pulley or clutch

R. Remove flywheel

S. Remove breaker point cover

T. Check contact point gap

U. Remove breaker points and check plunger hole

V. Check end play

W. File burrs from crankshaft power take-off end

X. Remove base or sump

Y. Remove oil slinger and bracket

Z. Remove cam gear

AA. Remove tappets

BB. Remove connecting rod and piston

CC. Remove crankshaft

DD. Test condenser

EE. Test coil

FF. Check cylinder bore, valve guides, and bearings

GG. Remove piston from connecting rod

JOB SHEET #1

HH. Check piston, rings, and piston pin

II. Reface valves

JJ. Re-seat valve seats

ENGINE OPERATION—PART I
UNIT V

JOB SHEET #2--REASSEMBLE A SMALL GASOLINE ENGINE

I. Tools and materials needed

- A. 3/8" drive socket set
- B. Combination wrench set
- C. Standard screwdriver
- D. Soft mallet
- E. Adjustable wrench
- F. Punch
- G. Ring compressor
- H. Starter wrench
- I. Flywheel holder
- J. Spring compressor

II. Procedure

- A. Install crankshaft
- B. Assemble piston pin and connecting rod
- C. Assemble rings to piston
- D. Install piston and connecting rod assembly
- E. Install tappets
- F. Install cam gear
- G. Install oil slinger, gear, and bracket
- H. Install base or sump with gasket
- I. Check and adjust end play
- J. Install points, adjust gap, and clean
- K. Install point cover

JOB SHEET #2

L. Install flywheel

M. Install starter pulley or clutch

N. Install governor blade

O. Adjust armature air gap

P. Check spark

Q. Adjust valve tappet clearance

R. Install valves, springs, and retainers

S. Recheck valve tappet clearance

T. Install breather assembly

U. Install cylinder head and shield

V. Test, clean gap, and install spark plug

W. Check compression

X. Install muffler

Y. Install carburetor and linkage

Z. Check and align governor

AA. Install shroud housing

BB. Install fuel pipe

CC. Fill with oil

DD. Adjust carburetor

EE. Start engine

ENGINE OPERATION—PART I
UNIT V

TEST

1. Define the following terms.

   a. Score--

   b. Stroke--

   c. Spark plug--

   d. Cylinder block--

   e. Carburetor--

2. List five machines that are powered by a small gasoline engine.

   a.

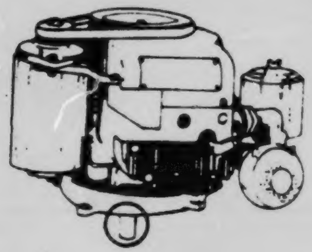
   b.

   c.

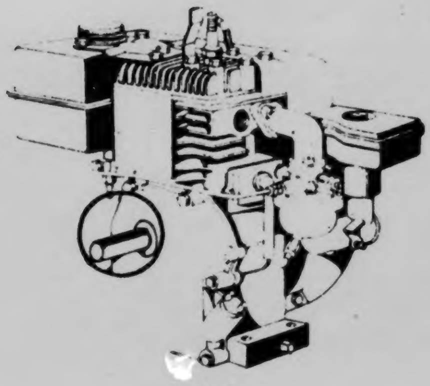
   d.

   e.

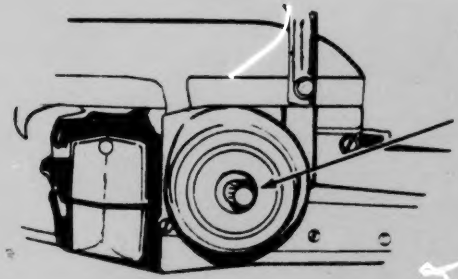
3. Identify the operating position of each engine from the drawings below.



a. ____



b. ______________________________



c. ______________________________

4. Name and describe the four principal events in the operation of a 4-cycle engine.

   a.

   b.

   c.

   d.

5. What is the difference between a 4-cycle and a 2-cycle engine?

6. Name three advantages of an air-cooled engine.

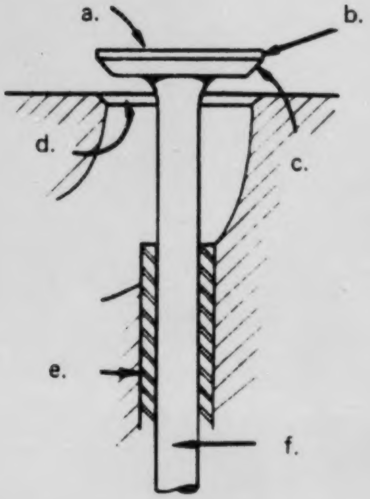
   a.

b.

c.

7. What is one way of making a very simple compression test?

8. Identify the valve parts.



a. ______________________________

b. ______________________________

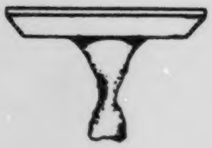
c. ______________________________

d. ______________________________

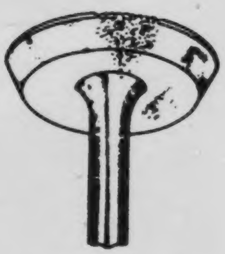
e. ______________________________

f. ______________________________

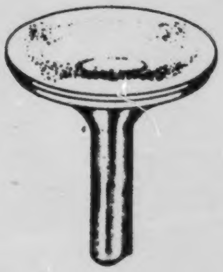
9. Identify the following types of valve failures.



a. ______________________________



b. ______________________________



c. ______________________________

10. Demonstrate the ability to:

    a. Disassemble a small gasoline engine.

    b. Reassemble a small gasoline engine.

ENGINE OPERATION—PART I
UNIT V

ANSWERS TO TEST

1. a. A scratch, ridge, or groove marring a finished surface

   b. The distance moved by the piston

   c. A device inserted into the combustion chamber of an engine containing an insulated control electrode for conducting current

   d. The largest single part of an engine; the basis or main mass of metal in which the cylinders are bored or placed

   e. A device for automatically mixing fuel in the proper proportion with air to produce a combustible gas

2. Any five of the following:

   a. Motorcycles

   b. Chain saws

   c. Mowers

   d. Outboard motors

   e. Pumps

   f. Posthole diggers

   g. Elevators

3. a. Vertical

   b. Horizontal

   c. Multi-position

4. a. Intake--exhaust valve is closed; intake valve is open; piston moves downward and the air-fuel mixture is drawn into the cylinder

   b. Compression--intake valve closes; piston moves upward; air-fuel mixture is compressed

   c. Power--spark occurs, igniting the mixture; forces of expanding gases push the piston down

d. Exhaust--exhaust valve opens; upward movement of piston forces burned gases out of cylinder; exhaust valve closes; cycle is repeated

5. a. 4-cycle, two revolutions of crankshaft per firing, lubricated from crankcase oil in the sump

   b. 2-cycle, one revolution of crankshaft per firing, lubricated from oil mixed with the gasoline

6. a. No need for complicated cooling system

   b. Lighter in weight and occupies less space

   c. Easy to repair

7. Give the flywheel a quick spin, and if it rebounds on the compression stroke, the compression is at least good enough to start the engine

8. a. Head

   b. Margin

   c. Face

   d. Seat

   e. Valve guide

   f. Stem

9. a. Necked

   b. Burned

   c. Dished

10. Performance skills will be evaluated by the instructor.

ENGINE OPERATION PART II
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify valve parts, piston rings, types of carburetors, parts of a carburetor and the parts of a magneto ignition system. The student should be able to describe the functions of the piston rings, carburetion system and ignition system. The student should also be able to describe types of valve failures and faulty compression. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Name the simple rule for testing compression.
2. Name ten factors that can cause faulty compression.
3. Identify the parts of a valve when given a drawing illustrating the parts.
4. Identify three types of valve failures when given a drawing showing each type.
5. Name three functions of piston rings.
6. Name the types of piston rings when given a drawing showing each type.
7. Describe the primary functions of the carburetion system.
8. Name the three basic types of carburetors.
9. Describe the operating principle of the carburetor.
10. Identify the parts of a float-type carburetor when given a drawing illustrating the parts.
11. Name the two basic types of small engine ignition systems.
12. Describe the function of the ignition system.
13. Identify the parts of the ignition system when given a drawing illustrating the parts.

ENGINE OPERATION PART II
UNIT VI

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheets.

  F. Give test.

II. Students:

  A. Read objectives.

  B. Study information sheets.

  C. Take test.

INSTRUCTION MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheets

  C. Transparency masters:

    1. TM-1 — Testing Compression

    2. TM-2 — Causes of Poor Compression

    3. TM-3 — Valve Parts

    4. TM-4 — Types of Valve Failures

    5. TM-5 — Types of Piston Rings

    6. TM-6 — Fuel Supply Systems

    7. TM-7 — Carburetor Operating Principle

INSTRUCTION MATERIALS

8. TM-8 – Carburetor Choke Valve
9. TM-9 – Carburetor Adjusting Valve
10. TM-10 – Float-Type Carburetor
11. TM-11 – Parts of a Float Carburetor
12. TM-12 – Parts of Magneto Ignition System

D. Test

E. Answers to test

II. References:

A. *Small Engine Care, Operation, Maintenance, and Repair*, Volumn I, American Association for Agriculture Engineering and Vocational Agriculture. (Purchase from Agricultural Engineering Department, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska 68583.)

B. *Briggs and Stratton Repair Instruction III*, Briggs and Stratton Corporation, Milwaukee, Wisconsin.

C. *General Theories of Operation*, Briggs and Stratton Corporation, Milwaukee, Wisconsin.

D. *Small Gasoline Engines Student Handbook*, Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

E. *Small Engines – Principles of Operation, Trouble Shooting, and Tune-Up*, University of Illinois, College of Agriculture, Vocational Agriculture Service, Urbana, Illinois.

ENGINE OPERATION PART II
UNIT VI

INFORMATION SHEET

I. Testing compression – Give the flywheel a quick spin and if it rebounds on the compression stroke, the compression is at least good enough to start the engine. (Transparency 1)

II. Causes of poor compression. (Transparency 2)

A. No compression or poor compression indicates these possibilities:

1. Worn cylinder
2. Worn piston rings
3. Leaking gaskets
4. Worn piston
5. Leaking valves which can be caused by:
    a. seats burned
    b. valves burned
    c. valve springs weak or broken
    d. valve stem warped or sticking in valve guide
6. Loose spark plug
7. Loose cylinder head bolts
8. Warped cylinder head
9. Broken connecting rod
10. Insufficient tappet clearance

III. Parts of a valve (Transparency 3)

A. Head

B. Margin

C. Seat

D. Face

E. Stem

F. Valve guide

INFORMATION SHEET

IV. Valve failures (Transparency 4)

A. Burned

B. Necked

C. Dished

V. Functions of piston rings

A. Form a gas tight seal between the piston and cylinder

B. Helps cool the piston by transferring heat

C. Control lubrication between piston and cylinder wall

VI. Types of piston rings (Transparency 5)

A. Compression rings — prevent gases from leaking by the piston during the compression and power strokes.

B. Oil control ring — is the bottom ring on the piston. Its job is to wipe the excess oil from the cylinder wall.

VII. Primary functions of the carburetion system

A. To atomize the fuel

B. Mix the atomized fuel with the proper proportion of air

C. Vaporize the fuel-air mixture

D. Deliver the mixture to the combustion chamber

VIII. Basic types of carburetors (Transparency 6)

A. Natural draft

B. Updraft

C. Downdraft

(NOTE: Carburetor types are referred to in most small engine references as gravity feed or float-type, suction feed and pressure feed. Actually these are types of fuel delivery styles. To be consistent with the reference sources, carburetor types will be referred to in this unit as *gravity feed or float type, suction lift and pressure feed.)*

INFORMATION SHEET

IX. Operation of the carburetor (Transparencies 7, 8, 9, & 10)

   A. Air enters the carburetor through the air inlet on the intake or suction stroke of the engine. As it reaches the restricted section of the air passage called the "venturi," its velocity is greatly increased. This causes fuel to be drawn out of the fuel nozzle and atomized, similar to the action of a fly sprayer. Speed control is provided by placing a flat disk called a "butterfly" in the carburetor throat above the venturi.

X. Parts of a float-type carburetor (Transparency 11)

   A. Fuel inlet

   B. Float needle seat

   C. Float needle

   D. Nozzle

   E. Packing nut

   F. High-speed needle valve

   G. Throttle valve

   H. Idle needle valve

   I. Venturi

   J. Float

   K. Choke valve

XI. Small engine ignition systems

   A. Magneto system — the two most commonly used magnetos are the flywheel and the external types.

   B. Battery system — Used on garden tractors, lawn mowers and some stationary engines. Some small engines are equipped with battery and magneto ignition systems.

INFORMATION SHEET

XII. Function of the ignition system

A. To furnish a spark at the proper time which is strong enough to ignite the fuel-air mixture in the combustion chamber.

XIII. Parts of the ignition system (Transparency 12)

A. Armature

B. Coil

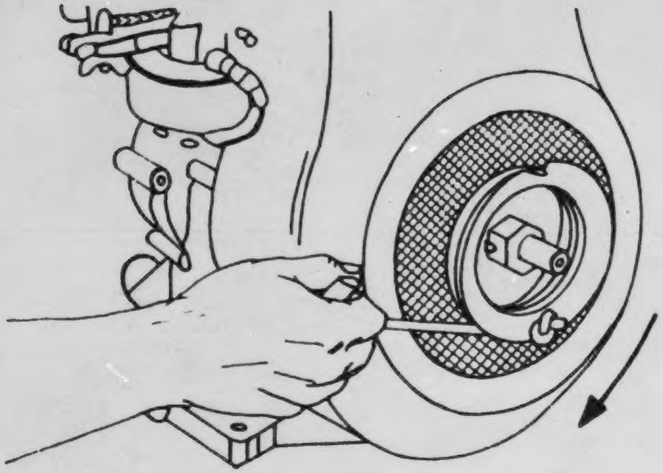
C. Magnet

D. Condenser

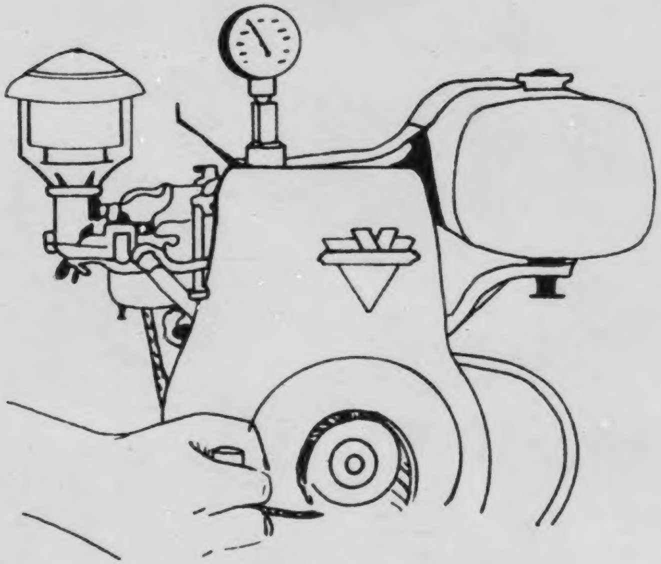
E. Breaker points

F. Spark plug

TESTING COMPRESSION



CHECK REBOUND TO CRANKING



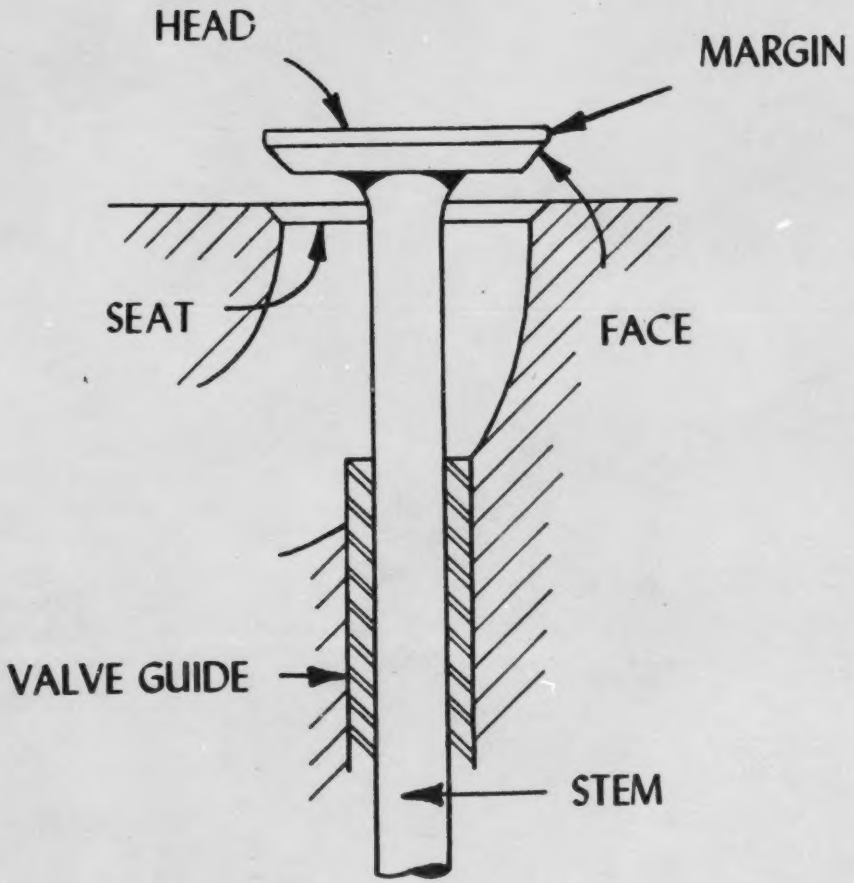
CHECK WITH COMPRESSION TESTER

CAUSES OF POOR COMPRESSION

NO COMPRESSION OR POOR COMPRESSION INDICATES THESE POSSIBILITIES:

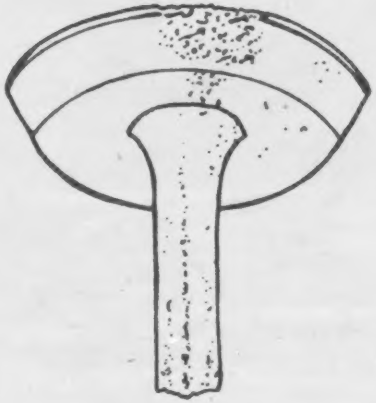
1. WORN CYLINDER
2. WORN PISTON RINGS
3. LEAKING GASKETS
4. WORN PISTON
5. LEAKING VALVES WHICH CAN BE CAUSED BY:
    a. SEATS BURNED
    b. VALVES BURNED
    c. VALVE SPRINGS WEAK OR BROKEN
    d. VALVE STEM WARPED OR STICKING IN VALVE GUIDE
6. LOOSE SPARK PLUG
7. LOOSE CYLINDER HEAD BOLTS
8. WARPED CYLINDER HEAD
9. BROKEN CONNECTING ROD
10. INSUFFICIENT TAPPET CLEARANCE

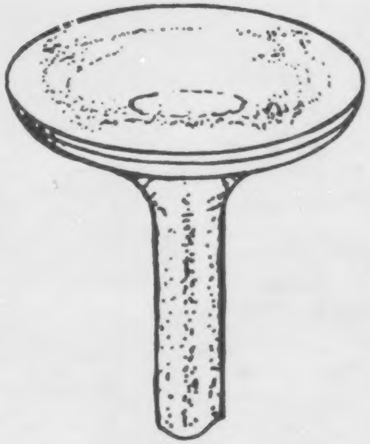
VALVE PARTS


HEAD
MARGIN
SEAT
FACE
VALVE GUIDE
STEM

TYPES OF VALVE FAILURES

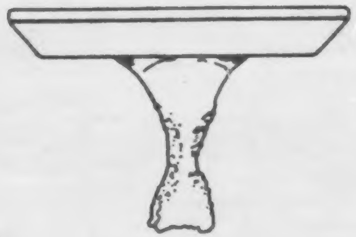
Burned



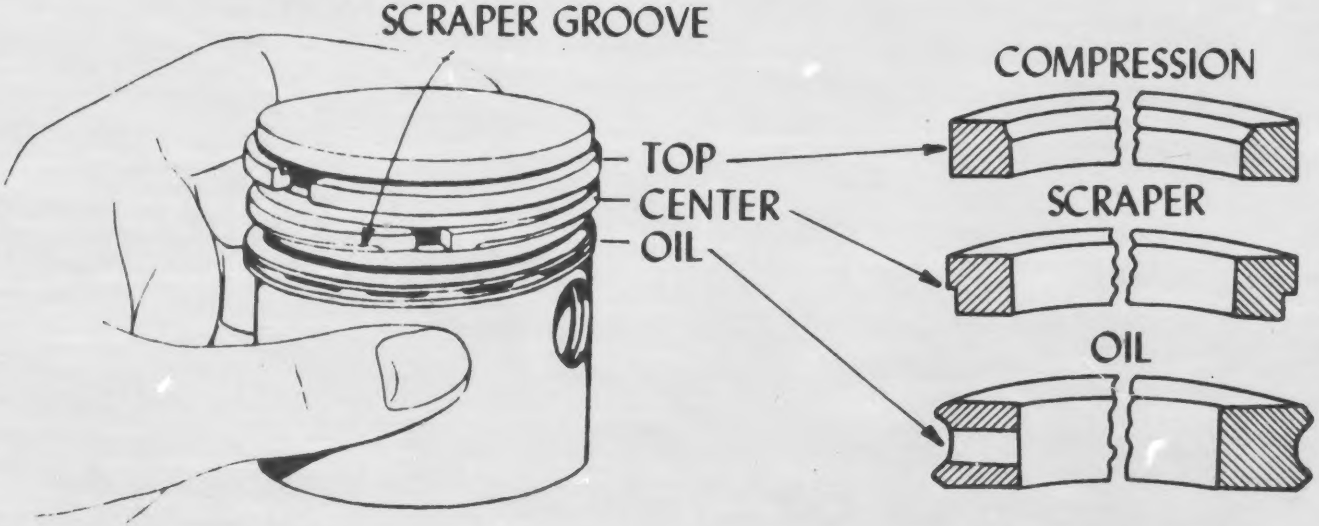


Dished

Necked



TYPES OF PISTON RINGS

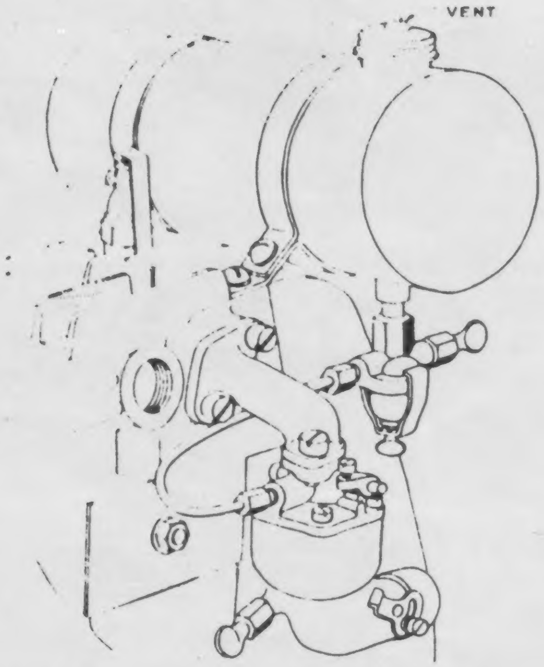

SCRAPER GROOVE
TOP
CENTER
OIL
COMPRESSION
SCRAPER
OIL

TM 5

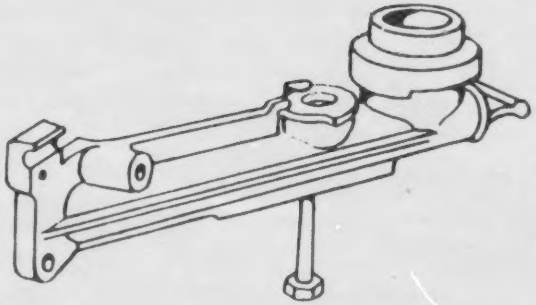
AM-195-B

FUEL SUPPLY SYSTEMS

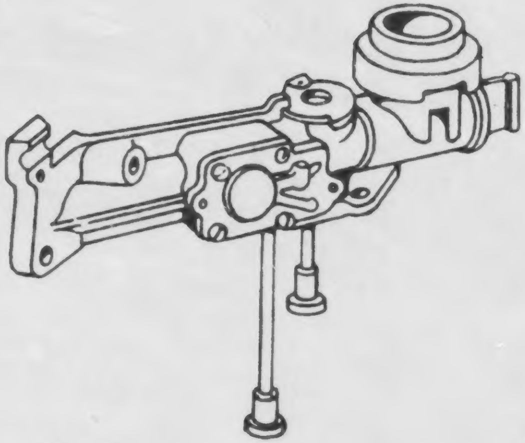
1. GRAVITY SYSTEM



2. SUCTION SYSTEM

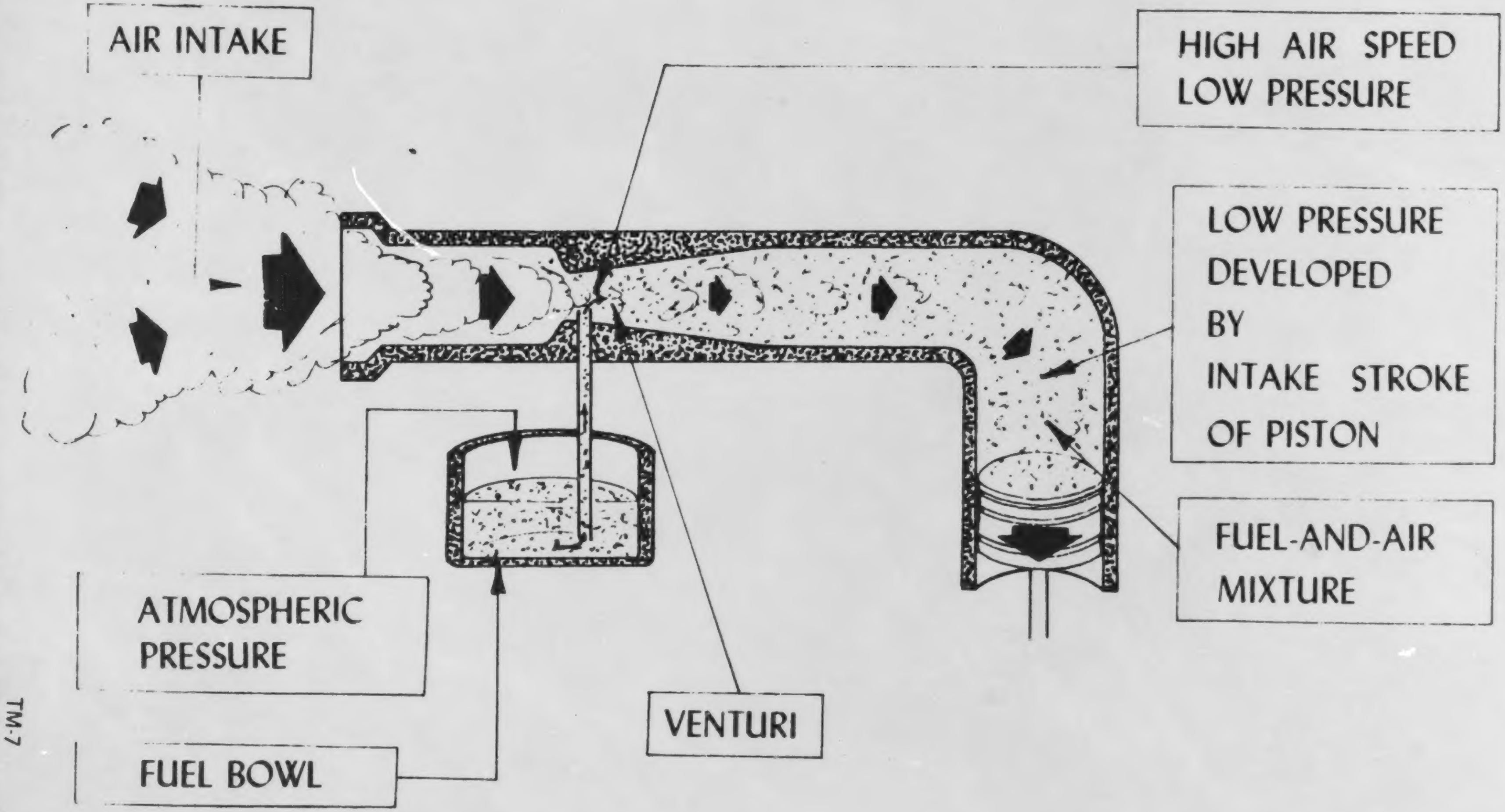


3. PUMP SYSTEM



CARBURETOR OPERATING PRINCIPLE

(4-CYCLE ENGINES)


AIR INTAKE

HIGH AIR SPEED
LOW PRESSURE

LOW PRESSURE
DEVELOPED
BY
INTAKE STROKE
OF PISTON

FUEL-AND-AIR
MIXTURE

ATMOSPHERIC
PRESSURE

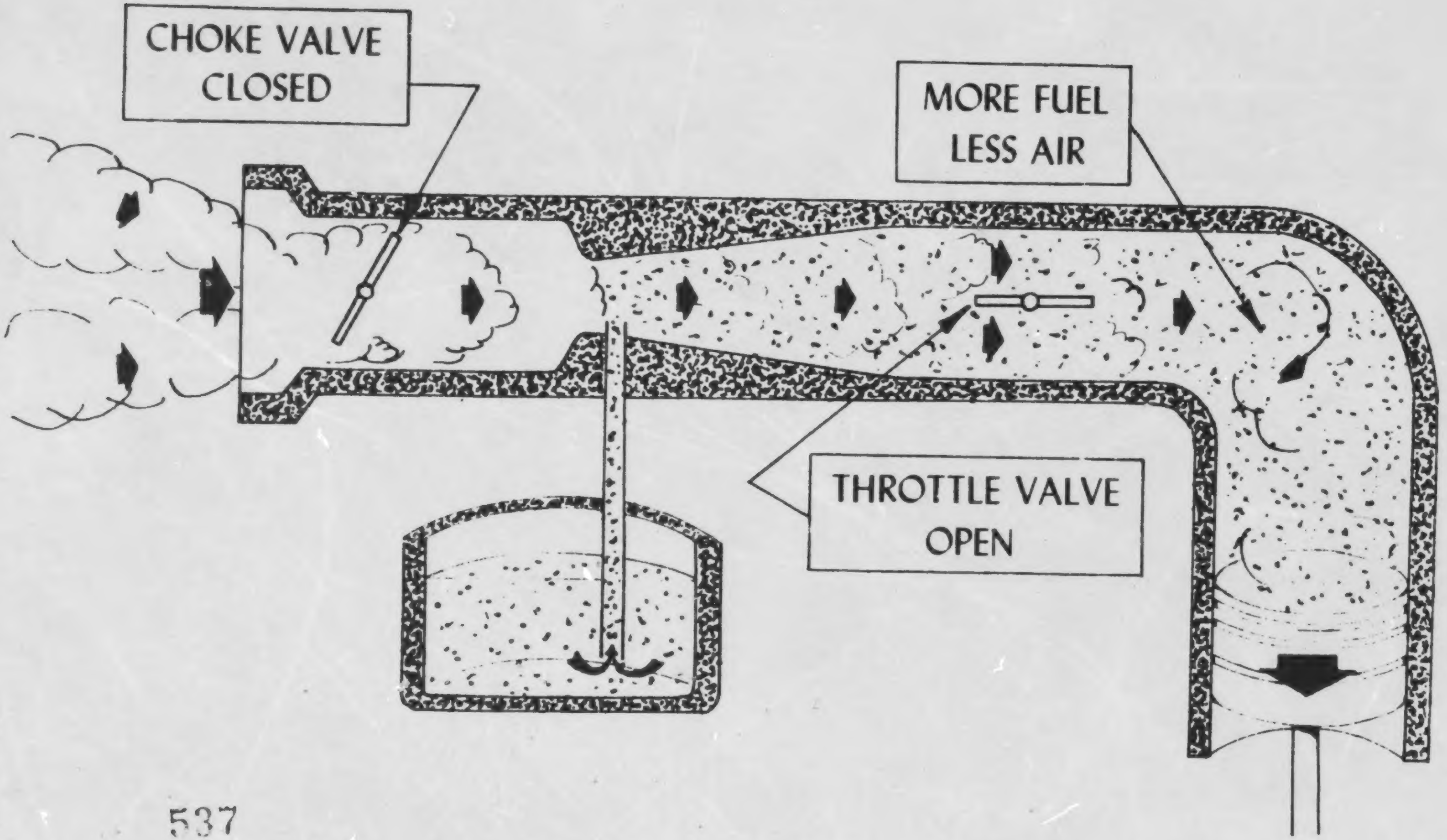
VENTURI

FUEL BOWL

TM-7

AM-199-B

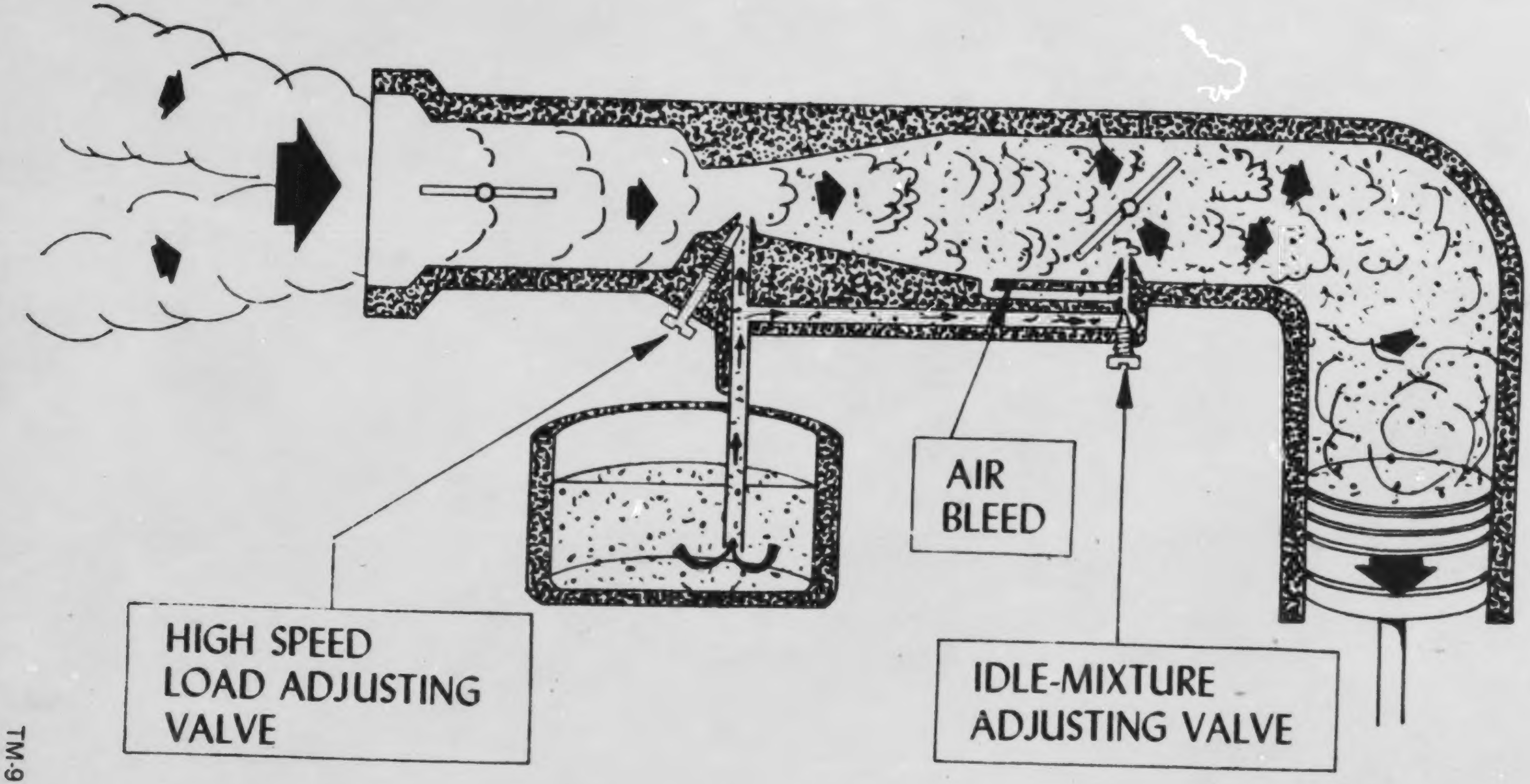
CARBURETOR CHOKE VALVE


CHOKE VALVE
CLOSED
MORE FUEL
LESS AIR
THROTTLE VALVE
OPEN

TM-8

AM-201-B

CARBURETOR ADJUSTING VALVE

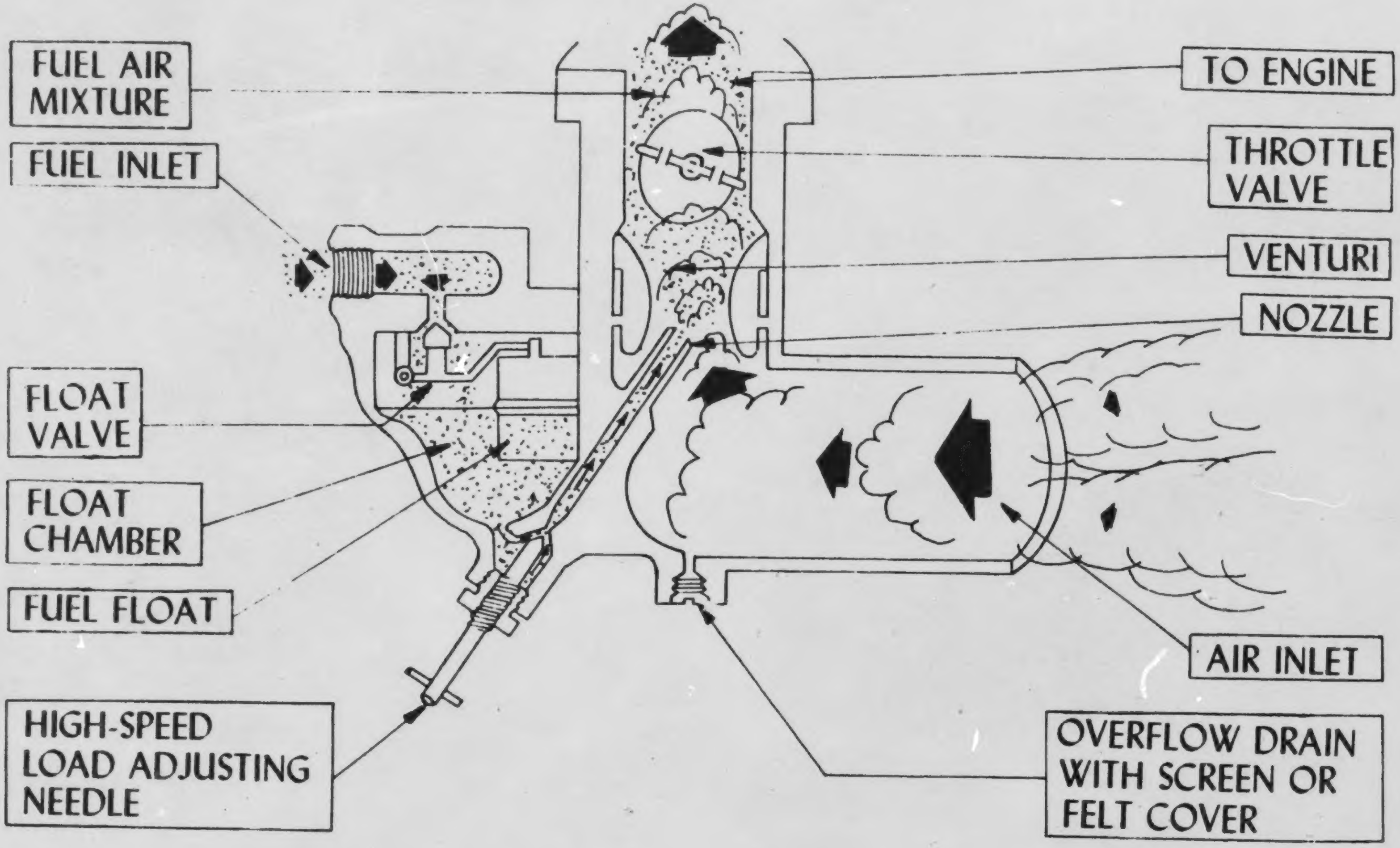

AIR
BLEED
HIGH SPEED
LOAD ADJUSTING
VALVE
IDLE-MIXTURE
ADJUSTING VALVE

TM-9

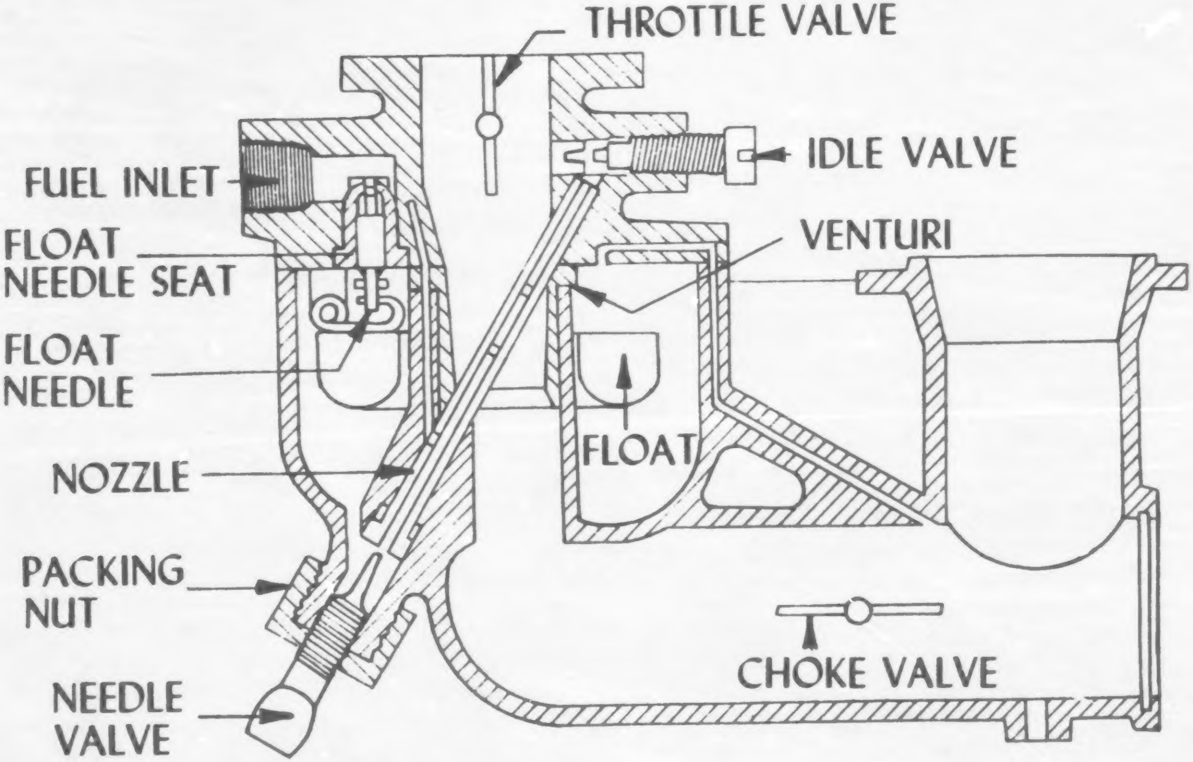
AM-203-B

FLOAT-TYPE CARBURETOR

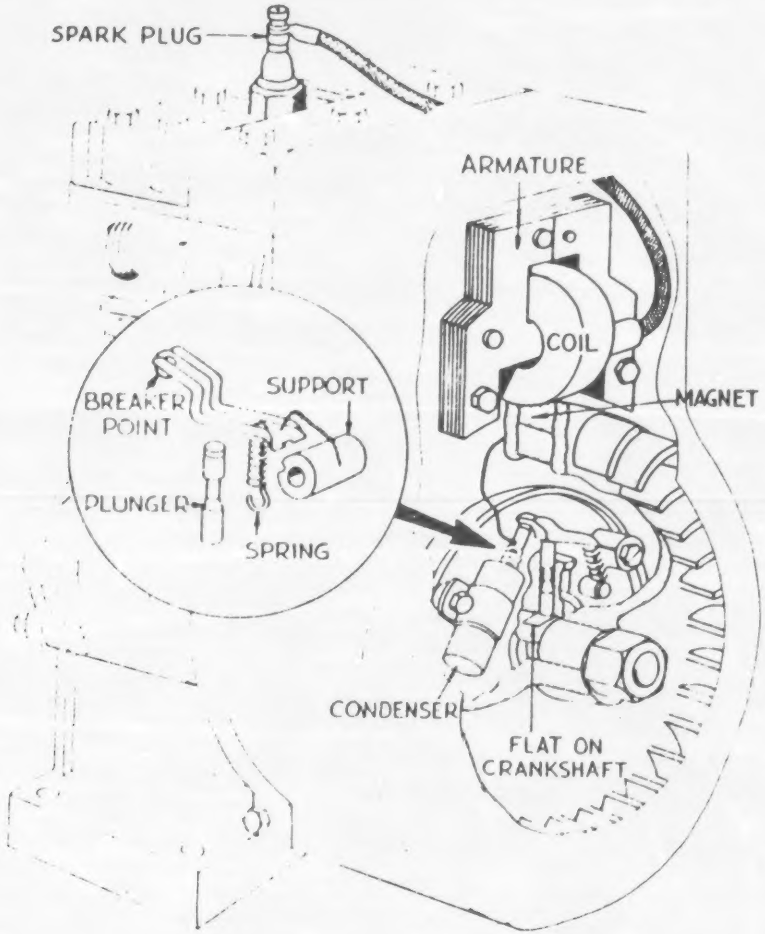
(CONSTANT LOAD AND SPEED)


FUEL AIR MIXTURE
FUEL INLET
FLOAT VALVE
FLOAT CHAMBER
FUEL FLOAT
HIGH-SPEED LOAD ADJUSTING NEEDLE
TO ENGINE
THROTTLE VALVE
VENTURI
NOZZLE
AIR INLET
OVERFLOW DRAIN WITH SCREEN OR FELT COVER

PARTS OF FLOAT CARBURETOR


THROTTLE VALVE
IDLE VALVE
FUEL INLET
FLOAT NEEDLE SEAT
VENTURI
FLOAT NEEDLE
FLOAT
NOZZLE
PACKING NUT
CHOKE VALVE
NEEDLE VALVE

PARTS OF MAGNETO IGNITION SYSTEM


SPARK PLUG
ARMATURE
COIL
MAGNET
BREAKER POINT
SUPPORT
PLUNGER
SPRING
CONDENSER
FLAT ON CRANKSHAFT

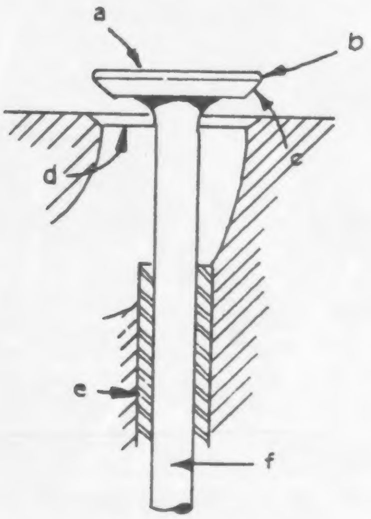
TM-12

AM-209-B

ENGINE OPERATION PART II
UNIT VI

TEST

1. Identify the valve parts.



a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

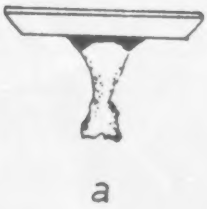
f. ______________________________

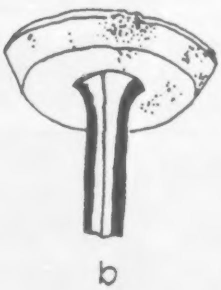
2. Identify the following types of valve failures.

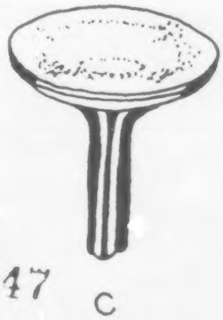
a. ____________________

b. ____________________

c. ____________________


a


b


C

TEST

3. What is one way of making a very simple compression test?

4. List five things that can cause poor compression.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

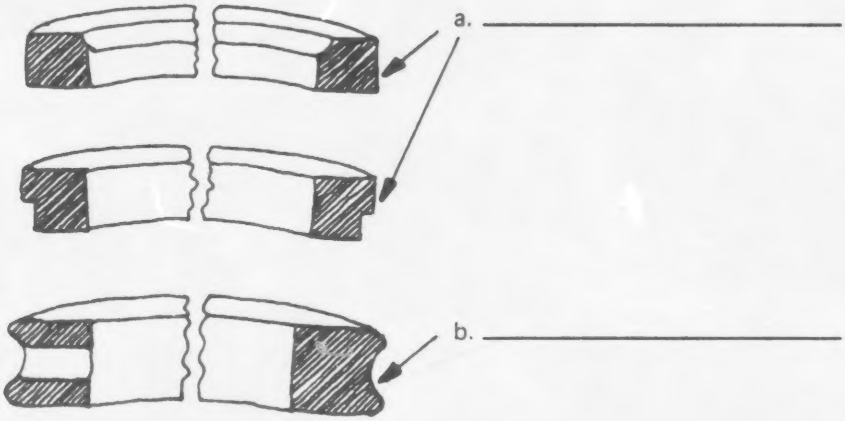
   e. ______________________________

5. What is the primary function of the following piston rings?

   a. Compression rings –

   b. Oil control ring –

6. Identify the types of piston rings.



TEST

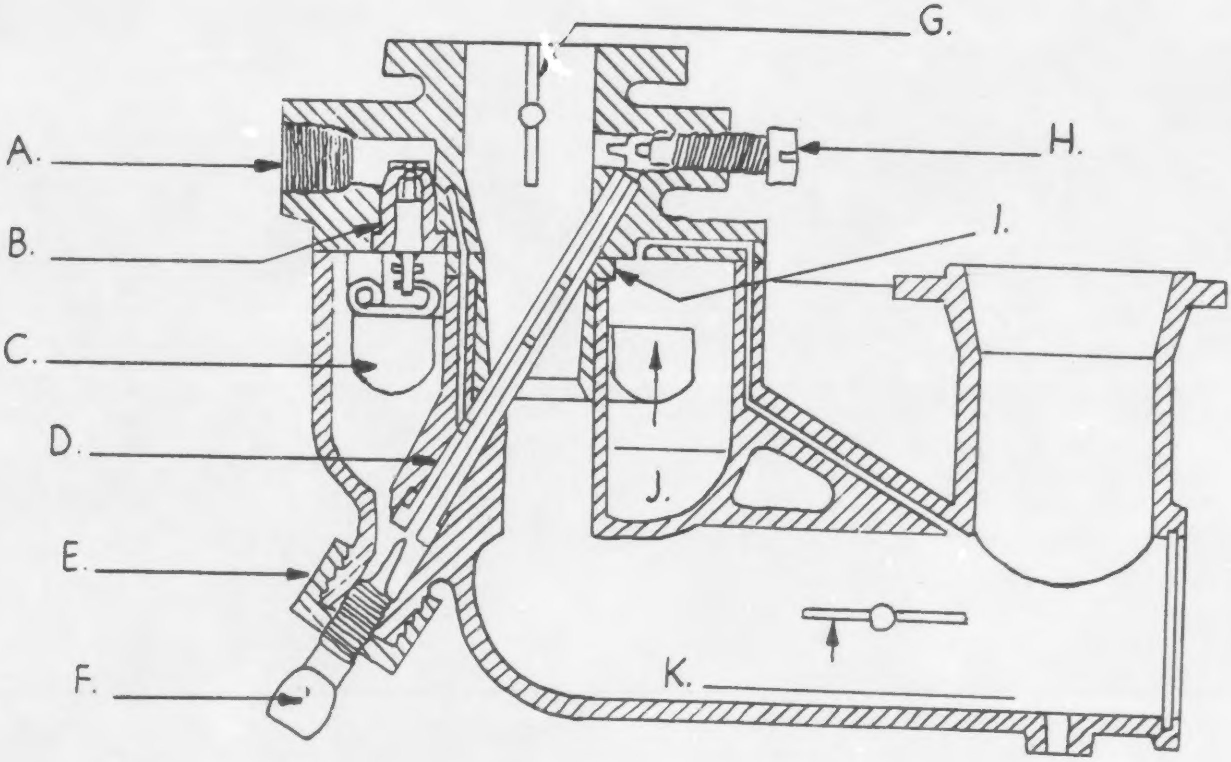
7. Name two primary functions of the carburetion system.

   a.

   b.

8. What is the purpose of the restricted section (venturi) in the carburetor air passage?

9. Identify the carburetor parts.



TEST

10. List two basic types of small engine carburetors.

a. ______________________________

b. ______________________________

11. What are the two most commonly used magneto systems found on small engines?

a. ______________________________

b. ______________________________

12. What is the function of the ignition system?

a. ____

____

____

13. Identify the magneto parts.

a. ____________________

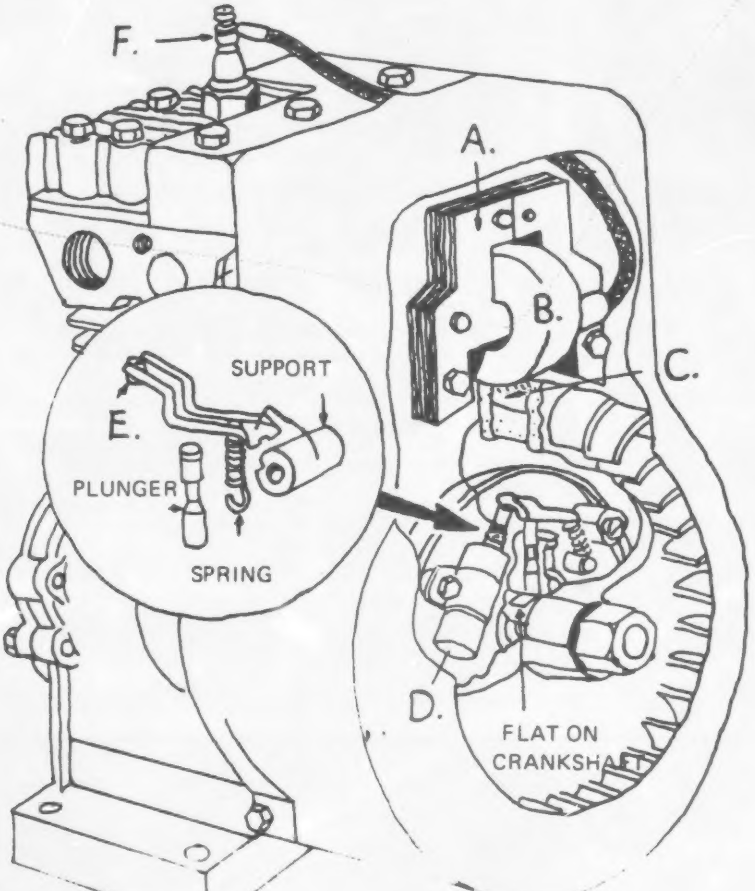
b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________


F.
A.
B.
C.
SUPPORT
E.
PLUNGER
SPRING
D.
FLAT ON CRANKSHAFT

ENGINE OPERATION PART II
UNIT VI

ANSWERS TO TEST

1. a. Head
   b. Margin
   c. Face
   d. Seat
   e. Valve guide
   f. Stem

2. a. Necked
   b. Burned
   c. Dished

3. Give the flywheel a quick spin, and if it rebounds on the compression stroke, the compression is at least good enough to start the engine.

4. Any five of the following:
   a. Worn cylinder
   b. Worn piston rings
   c. Leaking gaskets
   d. Worn piston
   e. Leaking valves
   f. Loose spark plug
   g. Loose cylinder head
   h. Warped cylinder head
   i. Broken connecting rod
   j. Insufficient tappet clearance

5. a. Compression rings prevent gases from leaking by the piston during the compression and power stokes.

   b. Oil control ring wipes the excess oil from the cylinder wall.

6. a. Compression rings

   b. Oil control ring

7. Any two of the following:

   a. Atomize the fuel
   b. Mix atomized fuel with the proper proportion of air
   c. Vaporize the fuel-air misture
   d. Deliver the mixture (fuel-air) to the combustion chamber

8. Increases the air velocity causing fuel to be drawn out of the fuel nozzle and atomized.

ANSWERS TO TEST

9. a. Fuel inlet
   b. Float needle seat
   c. Float needle
   d. Nozzle
   e. Packing nut
   f. High-speed needle valve
   g. Throttle valve
   h. Idle needle valve
   i. Venturi
   j. Float
   k. Choke valve

10. Any two of the following:
    a. Gravity feed, float-type
    b. Suction
    c. Pressure

11. a. Flywheel types
    b. External types

12. To furnish a spark at the proper time which is strong enough to ignite the fuel-air mixture in the combustion chamber.

13. a. Armature
    b. Coil
    c. Magnet
    d. Condenser
    e. Breaker points
    f. Spark plug

SERVICING SMALL ENGINES
UNIT VII

UNIT OBJECTIVE

After completion of this unit the student should be able to define terms associated with servicing small engines. The student should be able to identify the different types of air cleaners, fuel strainers, and carburetors and demonstrate skills in servicing small gasoline engines. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define five terms associated with servicing small engines.
2. Name three solutions used in cleaning an engine.
3. Identify given types of air cleaners.
4. Identify given types of fuel strainers.
5. Identify given types of carburetors.
6. Demonstrate the procedures for performing the following jobs:
    a. Clean and inspect crankcase and accessories.
    b. Clean and inspect cooling system.
    c. Service air cleaners.
    d. Service fuel strainers.
    e. Clean crankcase breather.
    f. Change crankcase oil.
    g. Check spark plug for proper operation.
    h. Clean and service spark plugs.

SERVICING SMALL ENGINES
UNIT VII

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheets.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Students:

  A. Read objectives.

  B. Study information sheets.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheets

  C. Transparency masters

    1. TM 1--Types of Air Cleaners

    2. TM 2--Types of Fuel Filters

    3. TM 3--Types of Carburetors

D. Job sheets

1. Job Sheet #1--Clean and Inspect Crankcase and Accessories
2. Job Sheet #2--Clean and Inspect Cooling System
3. Job Sheet #3--Service Oil-Bath Air Cleaner
4. Job Sheet #4--Service Oil-Filter Air Cleaner
5. Job Sheet #5--Service Dry-Filter Air Cleaner
6. Job Sheet #6--Service Sediment-Bowl Fuel Strainer
7. Job Sheet #7--Service Screen-Type Fuel Strainer
8. Job Sheet #8--Service Crankcase Breather
9. Job Sheet #9--Change Crankcase Oil
10. Job Sheet #10--Check Spark Plug for Proper Operation
11. Job Sheet #11--Service Spark Plugs

E. Test

F. Answers to test

II. References:

A. Small Engines Care, Operation, Maintenance, and Repair, Volume I. American Association for Agricultural Vocational Instructional Materials. (Purchase from Agriculture Engineering Department, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, Nebraska 68583.)

B. Briggs and Stratton Repair Instructions III. Milwaukee, Wisconsin: Briggs and Stratton Corporation.

C. General Theories of Operation. Milwaukee, Wisconsin: Briggs and Stratton Corporation.

D. Small Gasoline Engines Student Handbook. Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

SERVICING SMALL ENGINES
UNIT VII

INFORMATION SHEET

I. Terms and definitions

   A. Butterfly (throttle) valve--A device located in the manifold which controls the fuel and air

   B. Choke valve--A gate or valve which allows passage of gas or fluid in one direction only

   C. Spark gap--The space between the electrodes of a spark plug through which the spark jumps

   D. Detonation or knock--A hammering force on the piston rather than a uniform pushing force

   E. Air cleaner--A device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine

II. Engine cleaning solutions

   A. Commercial solvent called *degreaser*

   B. Petroleum solvents

      1. Kerosene

      2. Diesel fuel

   C. Live steam

III. Types of air cleaners (Transparency 1)

   A. Oil-bath

   B. Oil-filter

   C. Dry-filter

IV. Types of fuel strainers (Transparency 2)

   A. Combination screen and sediment bowl

   B. Screen in fuel tank

   C. Screen at end of fuel pickup hose

INFORMATION SHEET

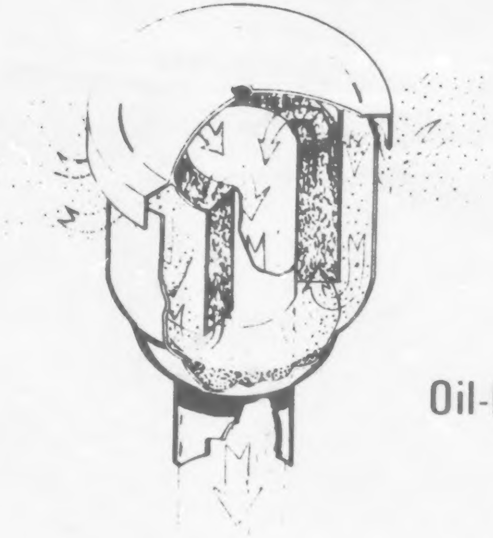
V. Types of carburetors (Transparency 3)

  A. Float

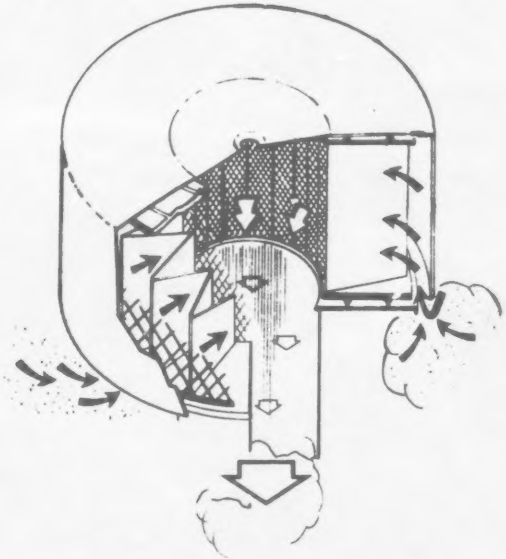
  B. Suction-lift

  C. Diaphragm

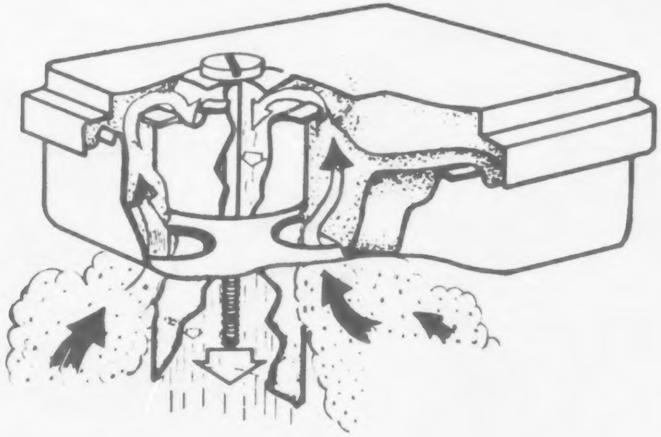
Types of Air Cleaners



Oil-Bath

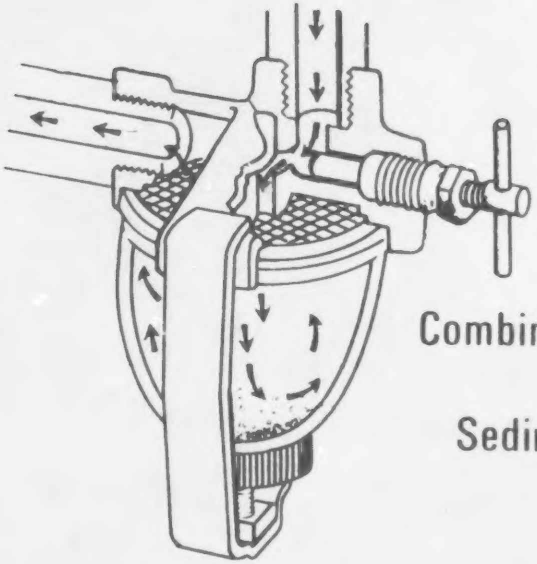


Dry-Filter

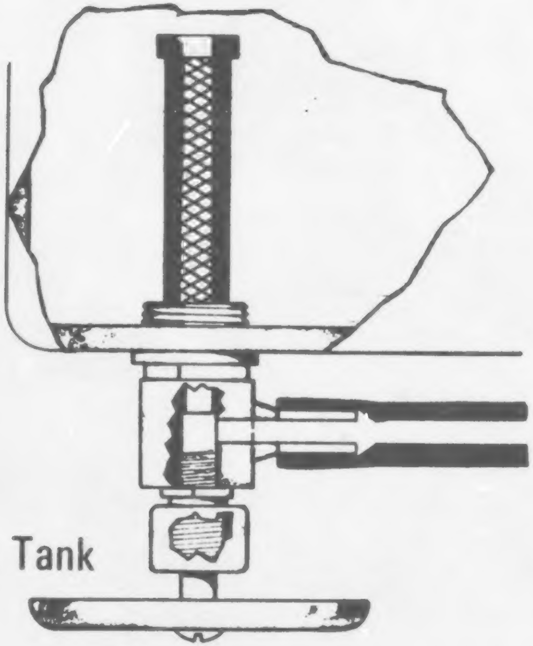


Oiled-Filter

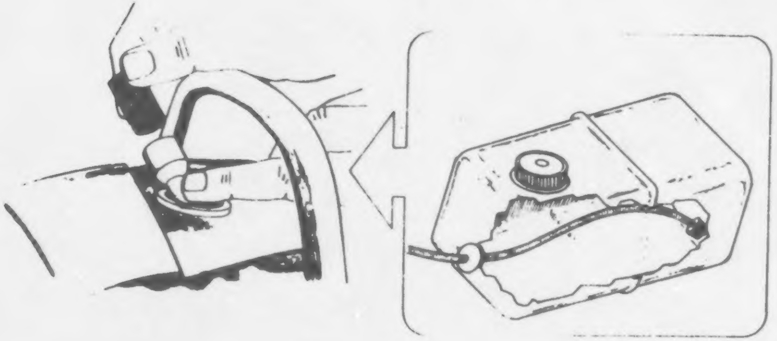
Types of Fuel Filters



Combination Screen
and
Sediment Bowl



Screen in Fuel Tank

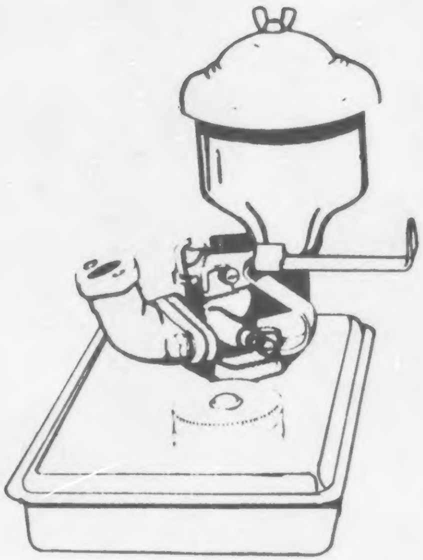


Strainer on Fuel
Pick-up Hose

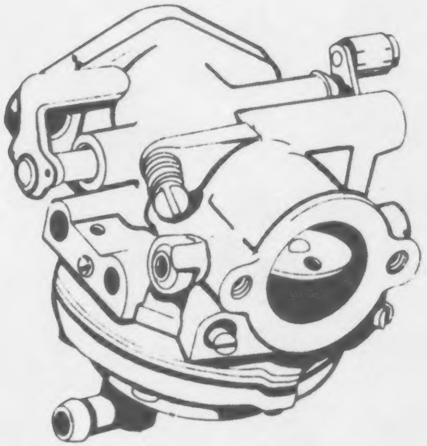
TM 2

AM-225-B

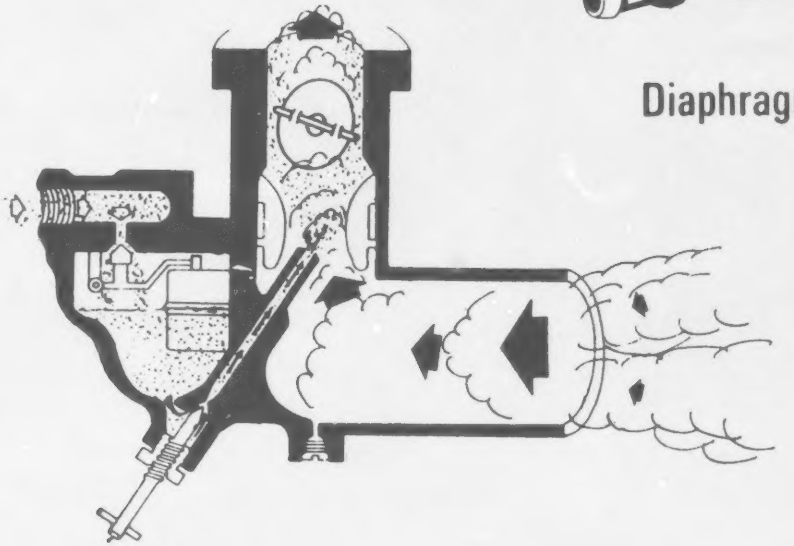
Types of Carburetors



Suction-Lift



Diaphragm



Float

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #1--CLEAN AND INSPECT CRANKCASE AND ACCESSORIES

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Socket set including:
  - 1. 3/8"
  - 2. 7/16"
  - 3. 1/2"
  - 4. 5/8"
  - 5. 9/16"
  - 6. 3/8" ratchet
- D. Open-end wrenches same as sockets
- E. Wire brush
- F. Empty pan for cleaning
- G. Paint brush
- H. Water hose with nozzle
- I. Scraper or putty knife
- J. Solvent
- K. Hand spray

(NOTE: Do not use gasoline for cleaning an engine. It is highly flammable and an extreme fire hazard. If a degreaser is used, check the instructions on the can.)

II. Procedures

- A. Allow the engine to cool, if it has been running
- B. Remove the blower shroud and cylinder baffles

JOB SHEET #1

C. Inspect for oil and fuel leaks

D. Remove air-cleaner and cover air-cleaner opening

(NOTE: Cover carburetor intake with a piece of plastic sheeting. Use a rubber band to hold plastic in place.)

E. Clean the exhaust system

F. Apply solvent on areas that need cleaning

(NOTE: Apply with a paint brush or hand sprayer until you notice a thin, well-distributed film.)

G. Allow solvent to set approximately five minutes

H. Remove solvent from the engine surface

1. If you used a degreaser, apply a strong stream of water
2. If you used a petroleum solvent, remove with a strong soap solution

I. Check for areas that have been missed

J. Remove protective covers

K. Replace carburetor air-cleaner

L. Start engine and operate for three to five minutes

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #2--CLEAN AND INSPECT COOLING SYSTEM

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Socket set
- D. Open-end wrench set
- E. Wire brush
- F. Scraper or putty knife

II. Procedures

A. Close the fuel shut-off valve

(NOTE: Not all engines have shut-off valves. If there is one, it may be either a part of the sediment bowl or a single unit.)

B. Remove fuel tank if necessary for removing the flywheel shroud

C. Remove the recoil starter or screened sheave if equipped with a self-starter

D. Remove the blower shroud

E. Remove remaining baffles and deflectors that direct air from shroud and over end area of cylinder

(NOTE: Do not operate the engine with the shroud and baffles removed.)

F. Clean inside of shroud and baffles with a small bristle brush or a putty knife

G. Clean intake screen by washing in solvent

H. Clean dirt from cylinder fins

I. Clean dirt from blower flywheel fins

J. Inspect engine for cracks, blemishes, and broken parts

K. Reassemble parts in reverse order

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #3--SERVICE OIL-BATH AIR CLEANER

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Container for washing parts
- D. Clean rags
- E. Wooden scraper
- F. Paint brush
- G. Solvent

  (NOTE: Do not use gasoline, naptha, or benzine. They are extremely flammable.)

II. Procedures

- A. Disconnect the spark plug wire
- B. Loosen oil cup or cover, and remove the air cleaner
  1. Secured by bail wire
  2. Secured by wing nut
  3. Secured by threaded stud
- C. Cover the exposed air intake
- D. Check depth of sediment deposit in bottom of oil cups
- E. Throw away dirty oil
- F. Clean cup, filter, and other parts with solvents
- G. Check air intake pipe to the carburetor for dirt accumulation
- H. Refill cap with oil to *oil level*
- I. Remove cover from intake
- J. Assemble the air cleaner; install and tighten
- K. Reconnect the spark plug wire

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #4--SERVICE OIL-FILTER AIR CLEANER

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Container for washing parts
- D. Clean rags
- E. Soap
- F. Paint brush

II. Procedures

- A. Disconnect the spark plug wire
- B. Clean area around air cleaner
- C. Remove filter element cover
- D. Remove filter element
- E. Check condition of the filter element and other parts of the air cleaner
- F. Cover carburetor air intake
- G. Clean filter
- H. Dry filter element
- I. Remove protective cover from the carburetor intake
- J. Clean the carburetor intake
- K. Oil the filter element with a few drops of oil
- L. Install filter element
- M. Install cover
- N. Reconnect spark plug wire

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #5--SERVICE DRY-FILTER AIR CLEANER

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Clean rags

II. Procedures

- A. Disconnect the spark plug wire
- B. Clean the area around the air cleaner
- C. Remove the filter element cover
- D. Remove the air filter element
- E. Cover the carburetor air intake with cloth or plastic
- F. Check condition of filter element and other parts
- G. Clean air filter element

  (NOTE: If filter element is paper, clean by tapping it on a flat surface.)

  (CAUTION: Do not wash it unless instructed to do so by the manufacturer.)

- H. Remove protective cover from the carburetor intake
- I. Clean filter cover and carburetor intake
- J. Replace filter element
- K. Replace cover
- L. Reconnect spark plug wire

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #6--SERVICE SEDIMENT-BOWL FUEL STRAINER

I. Tools and materials needed

   A. Open-end wrenches 7/16" and 1/2"

   B. Combination pliers

   C. Solvents

   D. Pan for cleaning parts

   E. Cleaning rags

   F. New gasket for glass bowl

II. Procedures

   A. Disconnect spark plug wire

   B. Close fuel shut-off valve

   C. Loosen jam nut and swing the wire bail to one side (Figure A)

   D. Remove bowl with a twisting motion (Figure A)

   E. Remove gasket (Figure A)

   F. Remove strainer (filter) screen (Figure A)

   G. Wash the screen or filter element

   H. Clean and then dry sediment bowl

   I. Open fuel valve and drain out approximately a cup of fuel (Figure B)

   (NOTE: Collect fuel in can to avoid a fire hazard.)

   J. Install gasket, strainer, and sediment bowl (Figure C)

   K. Fill the sediment bowl before tightening the jam nut

   L. Tighten bowl against gasket with jam nut

   M. Check for leaks before operating engine

JOB SHEET #6

N. Reconnect spark plug wire to spark plug

O. Operate engine for a few minutes and recheck for leaks

III. Diagram of procedure

Figure A

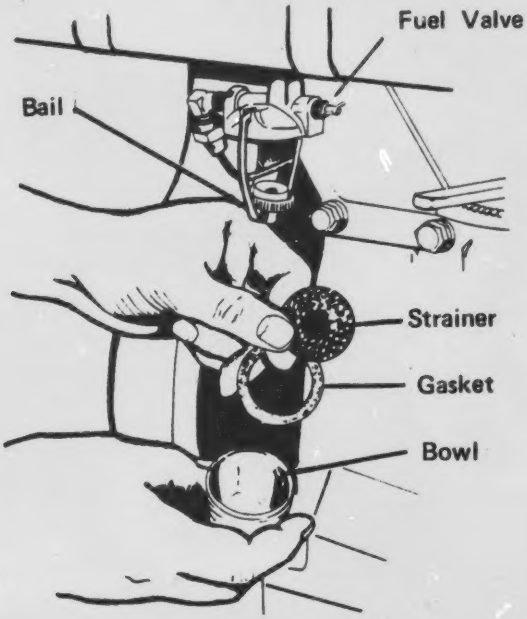

Fuel Valve
Bail
Strainer
Gasket
Bowl

Figure B

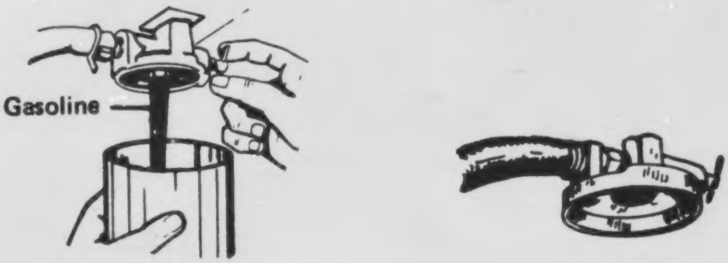
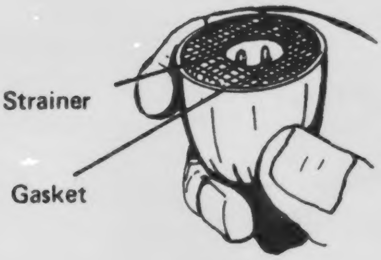

Drain Gasoline

Figure C


Strainer
Gasket

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #7--SERVICE SCREEN-TYPE FUEL STRAINER

I. Tools and materials needed

   A. Open-end wrenches 7/16" and 1/2"

   B. Combination pliers

   C. Solvent

   D. Pan for cleaning parts

   E. Cleaning rags

II. Procedures

   A. Disconnect the spark plug wire

   B. Close fuel shut-off valve (if one is installed)

   C. Remove fuel line from tank

   D. Remove fuel shut-off valve and/or fuel strainer from fuel tank if possible

   E. Clean fuel strainer

   F. Replace fuel strainer assembly in reverse order of removal

   G. Reconnect spark plug wire to spark plug

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #8--SERVICE CRANKCASE BREATHER

I. Tools and materials needed

  A. Open-end wrenches 7/16" and 1/2"

  B. Standard screwdriver 8"

  C. Combination pliers

  D. Clean rags

  E. Solvent

  F. Container for cleaning parts

  G. New gasket

II. Procedures

  A. Disconnect spark plug wire

  B. Check breather for proper operation

  C. Remove crankcase breather cover, if installed (Figure A)

  D. Remove the crankcase breather, if it is not a part of the cover

  E. Check breather valve for clearance (Figure B)

    1. Check reed valves with a feeler gauge

    2. Clearance should be .015" to .030"

  F. Disassemble crankcase breather (Figure C)

  G. Clean parts in petroleum solvent

  H. Reassemble and install breather

JOB SHEET #8

III. Diagram of procedure

Figure A

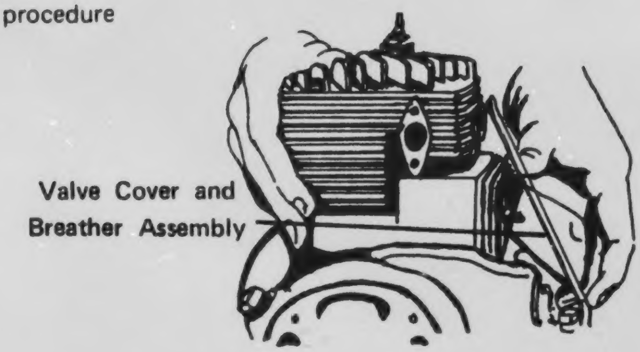

Valve Cover and
Breather Assembly

Figure B

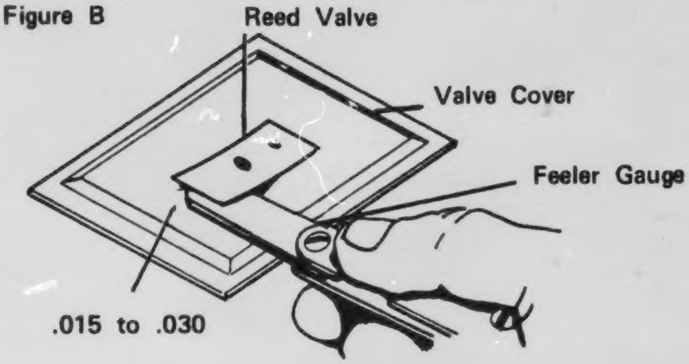
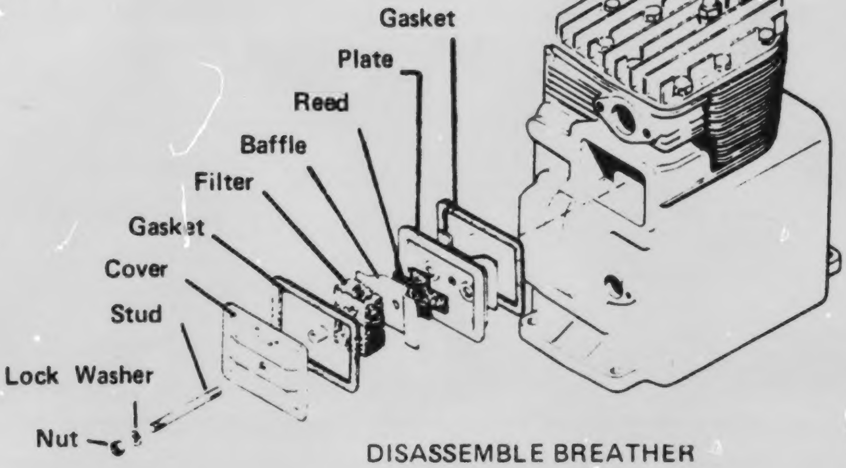

Reed Valve
Valve Cover
Feeler Gauge
.015 to .030

Figure C


Gasket
Plate
Reed
Baffle
Filter
Gasket
Cover
Stud
Lock Washer
Nut

DISASSEMBLE BREATHER

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #9--CHANGE CRANKCASE OIL

I. Tools and materials needed

   A. Standard screwdriver 8"

   B. Combination pliers

   C. End wrenches 7/16", 1/2", 9/16", and 5/8"

   D. Funnel

   E. Oil as recommended

   F. Container for old oil

   G. Clean rags

II. Procedures

   A. Operate engine until it is thoroughly heated

   B. Stop engine and disconnect the spark plug wire

   C. Locate drain plug (Figure A)

      1. Bottom of oil sump

      2. Under oil sump

      3. Some drained through filler neck

   D. Clean dirt from around plug before removing plug

   E. Remove drain plug

   F. Allow crankcase to drain for approximately five minutes

   G. Replace drain plug

   H. Refill crankcase with new oil

   (NOTE: Use type of oil recommended in the operator's manual.)

   I. Connect spark plug wire and start engine

   J. Check for oil leaks

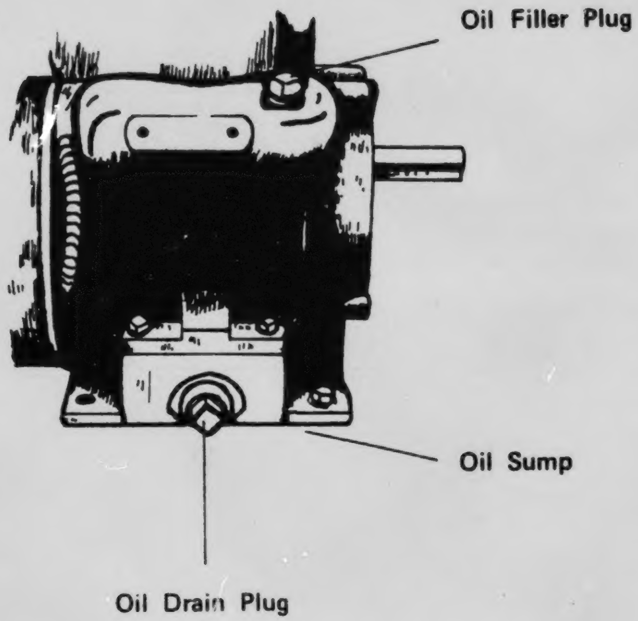
JOB SHEET #9

K. Stop engine

L. Recheck oil level

III. Diagram of procedure

Figure A


Oil Filler Plug
Oil Sump
Oil Drain Plug

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #10--CHECK SPARK PLUG FOR PROPER OPERATION

I. Tools and materials needed

- A. Spark plug deep sockets 13/16" x 3/8" and 3/4" x 3/8" drive
- B. Torque wrench handle 3/8" drive
- C. Feeler gauge
- D. Ignition file
- E. Pen knife
- F. Wire brush
- G. Small paint brush
- H. Pan of petroleum solvent

II. Procedures

- A. Disconnect the spark plug wire from the spark plug (Figure A)
- B. Loosen plug one or two turns, and then remove dirt
- C. Remove the spark plug (Figure B)
- D. Reconnect the spark plug wire
- E. Ground spark plug to the engine (Figure C)
- F. Crank the engine one or two turns
- G. Observe the spark at the electrode

  (NOTE: If there is no spark, or if spark is weak, proceed to next step.)
- H. Disconnect the spark plug wire from the spark plug
- I. Hold the end of the spark plug wire approximately 1/4 inch from the cylinder head, or use a spark tester (Figure D)
- J. Crank the engine one or two turns
- K. Observe the spark between spark plug wire and the cylinder head

  (NOTE: If the spark is blue-orange color, the ignition system is okay; the trouble is in the spark plug.)

JOB SHEET #10

III. Diagram of procedure

Figure A

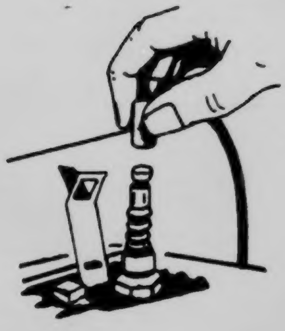
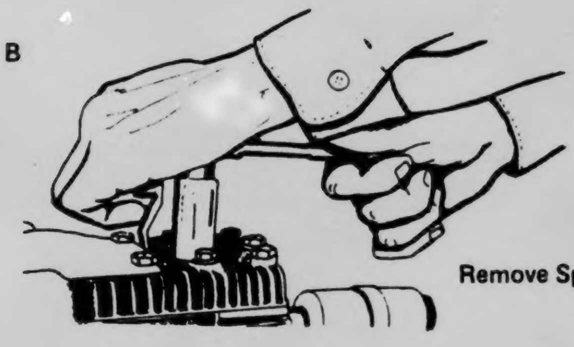
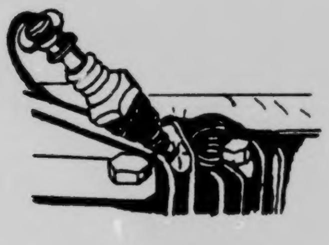

Metal Connector

Figure B



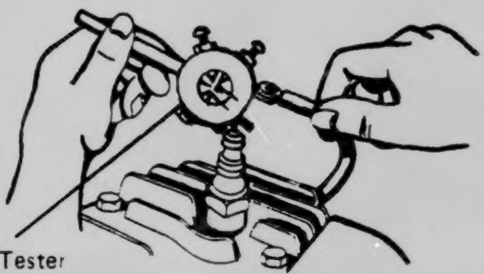
Remove Spark Plug

Figure C



Ground Spark Plug

Figure D


Adjustable Gap Spark Tester

SERVICING SMALL ENGINES
UNIT VII

JOB SHEET #11--SERVICE SPARK PLUGS

I. Tools and materials needed

   A. Spark plug deep sockets 13/16" x 3/8" and 3/4" x 3/8" drive

   B. Torque wrench handle 3/8" drive

   C. Feeler gauge

   D. Ignition file

   E. Pen knife

   F. Wire brush

   G. Small paint brush

   H. Pan of petroleum solvent

II. Procedures

   A. Check the condition of the plugs

   B. Remove oily deposits from plugs

   C. Clean threads with wire brush

   (NOTE: Do not brush the insulator. It will leave a metallic film which may provide an electrical short to ground.)

   D. Remove deposits from plugs (Figure A)

   E. Blow loose materials from plug with compressed air

   F. Bend the ground electrode enough to allow room for a thin point file (Figure B)

   (NOTE: Bend just enough to allow room for file; too much bending will break the ground electrode.)

   G. File electrodes on plugs until both have flat surfaces (Figure B)

   H. Bend the ground electrode back into its original position

   I. Determine proper spark gap spacing for your engine (Figure C)

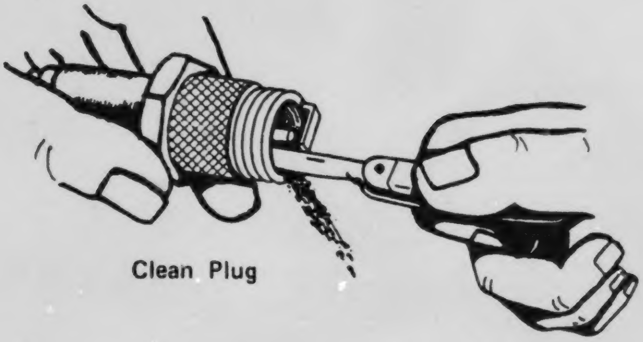
      1. Most plugs set on .025 inch

      2. Range from .020" to .040"

JOB SHEET #11

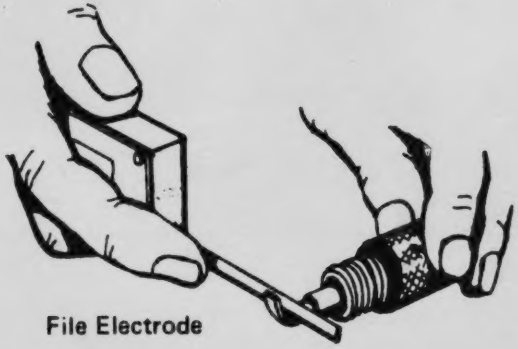
III. Diagram of procedure

Figure A



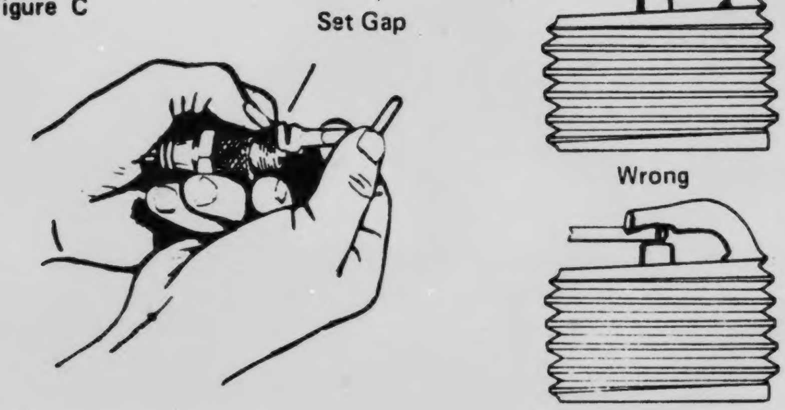
Clean Plug

Figure B



File Electrode

Figure C


Set Gap
Wrong
Right

CHECKING THE GAP

SERVICING SMALL ENGINES
UNIT VII

TEST

1. Define the following terms.

   a. Butterfly throttle valve--

   b. Air cleaner--

   c. Choke valve--

   d. Detonation or knock--

   e. Spark gap--

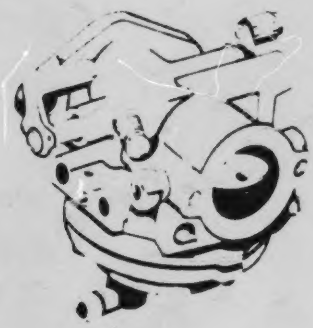
2. Name three solutions used in cleaning an engine.

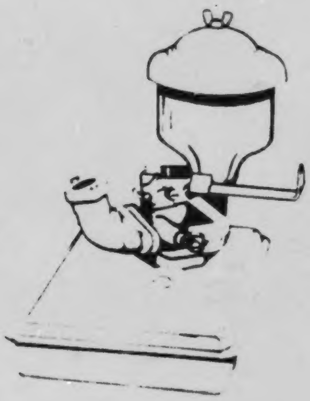
   a.

   b.

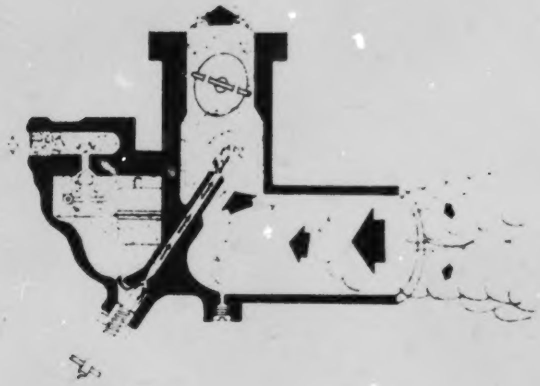
   c.

3. Identify the following types of carburetors.



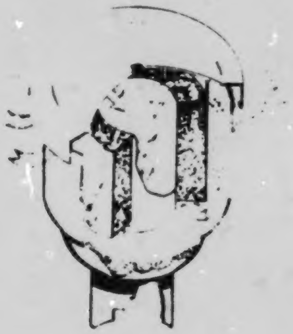


a.____________________________ b.____________________________

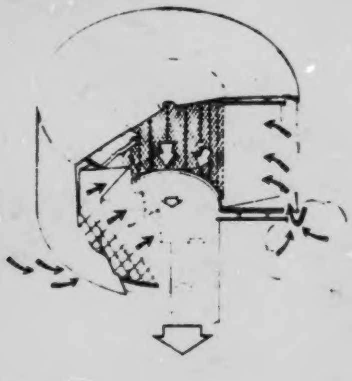


c.______________________________

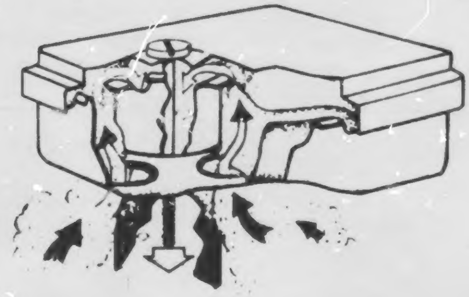
4. Identify the following types of air cleaners.



a.______________________________

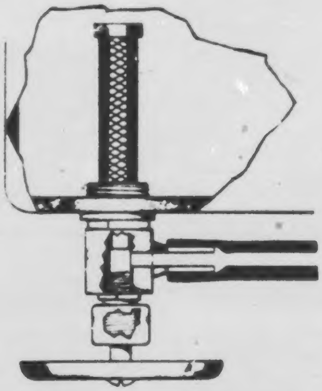


b.______________________________

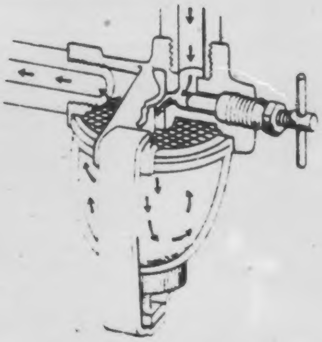


c.__________________________________

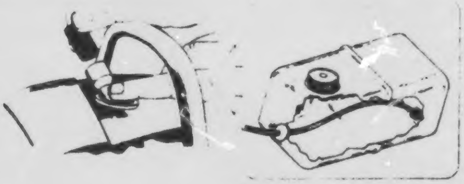
5. Identify the following types of fuel strainers.



a.__________________________________



b.__________________________________



c.________________________________

6. Demonstrate the procedures for performing the following jobs.

   a. Clean and inspect crankcase and accessories.

   b. Clean and inspect cooling system.

   c. Service air cleaners.

   d. Service fuel strainers.

   e. Clean crankcase breather.

   f. Change crankcase oil.

   g. Check spark plug for proper operation.

   h. Clean and service spark plugs.

SERVICING SMALL ENGINES
UNIT VII

ANSWERS TO TEST

1. a. Butterfly throttle valve--A device located in the manifold which controls the fuel and air

   b. Air cleaner--A device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine

   c. Choke valve--A gate or valve which allows passage of gas or fluid in one direction only

   d. Detonation or knock--A hammering force on the piston rather than a uniform pushing force

   e. Spark gap--The space between the electrodes of a spark plug through which the spark jumps

2. a. Commercial solvent

   b. Petroleum solvents

   c. Live steam

3. a. Diaphragm

   b. Suction-lift

   c. Float

4. a. Oil-bath

   b. Dry-filter

   c. Oil-filter

5. a. Screen in fuel tank

   b. Combination screen and sediment bowl

   c. Screen at end of fuel pickup hose

6. Performance skills will be evaluated by the instructor.

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

UNIT OBJECTIVE

After completion of this unit the student should be able to identify small engine problems, perform skills necessary to correct the problem(s) or determine that extensive repair or overhaul is necessary. This will be evidenced through demonstration and scoring eighty five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit the student should be able to:

1. Define five terms associated with small engine repair.
2. Name four common causes of ignition problems.
3. List four common compression problems.
4. Name four possible causes of fuel problems.
5. Demonstrate the ability to:
    a. trouble shoot ignition problems.
    b. use a magneto-coil-condenser tester.
    c. trouble shoot compression problems.
    d. trouble shoot fuel problems.

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

SUGGESTED ACTIVITIES

I. Instructor

  A. Provide students with objective sheets.

  B. Provide students with information, assignment and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Students

  A. Read objectives.

  B. Study information sheet.

  C. Complete assignment sheet.

  D. Demonstrate the ability to accomplish the procedures outlined in the job sheet.

  E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit.

  A. Objectives

  B. Information sheets.

  C. Transparency masters.

    1. TM 1--Setting Edge Distance

    2. TM 2--Conditions of Spark Plugs

INSTRUCTIONAL MATERIALS

D. Job sheets.

   1. No. 1 Trouble shooting ignition problem.
   2. No. 2 Magneto, coil, condenser test.
   3. No. 3 Trouble shooting compression problems.
   4. No. 4 Trouble shooting fuel problems.

E. Test

F. Answer to test

II. References

A. *Skill Sheets for Small Gasoline Engines*, Iowa State University, Ames, Iowa.

B. *Small Engine Trouble Shooting Chart*, Monis Sales Company, 227 East Ross Street, Lancaster, Pennsylvania 17602.

C. *Small Engine Trouble Shooting*, New Mexico State University, Agriculture and Extension Education, Las Craces, New Mexico.

D. *Suggest Lesson Plans for Gasoline Engines in Vocational Agriculture*, State Department of Education, Santa Fe, New Mexico.

E. *Small Engines - Care - Operation - Maintenance & Repair*, Volume 1 & 2, AAVIM, Coordinators Office, Agriculture Engineering Center, Athens, Georgia.

F. *General Theories of Operation*, Briggs and Stratton Corp., Milwaukee, Wisconsin.

G. *Repair Instructions*, Briggs and Stratton Corp., Milwaukee, Wisconsin.

H. *Small Gasoline Engines, (Ornamental Horticulture) - A Laboratory Guide for Teachers*, Vocational Education Productions, California State Polytechnical College, San Luis Obispo, California.

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

   A. Trouble shooting--The process of elimination involved in determining the part or parts malfunctioning in an engine.

   B. Tune up--Periodic or occasional adjustments and/or rejuvenation of systems to meet or maintain specifications for efficient and maximum performance.

   C. Magneto-coil-condenser tester--An instrument used to check the magneto-coil and condenser for proper operation.

II. Ignition problems

   A. Faulty or inadequate spark

   B. Improper ignition timing

   C. Faulty ignition wiring

   D. Dirty or defective spark plug

III. Compression problems

   A. Faulty cylinder head

   B. Faulty head gasket

   C. Worn piston rings

   D. Faulty valves

   E. Improperly adjusted valves

   F. Improper valve tappet clearance

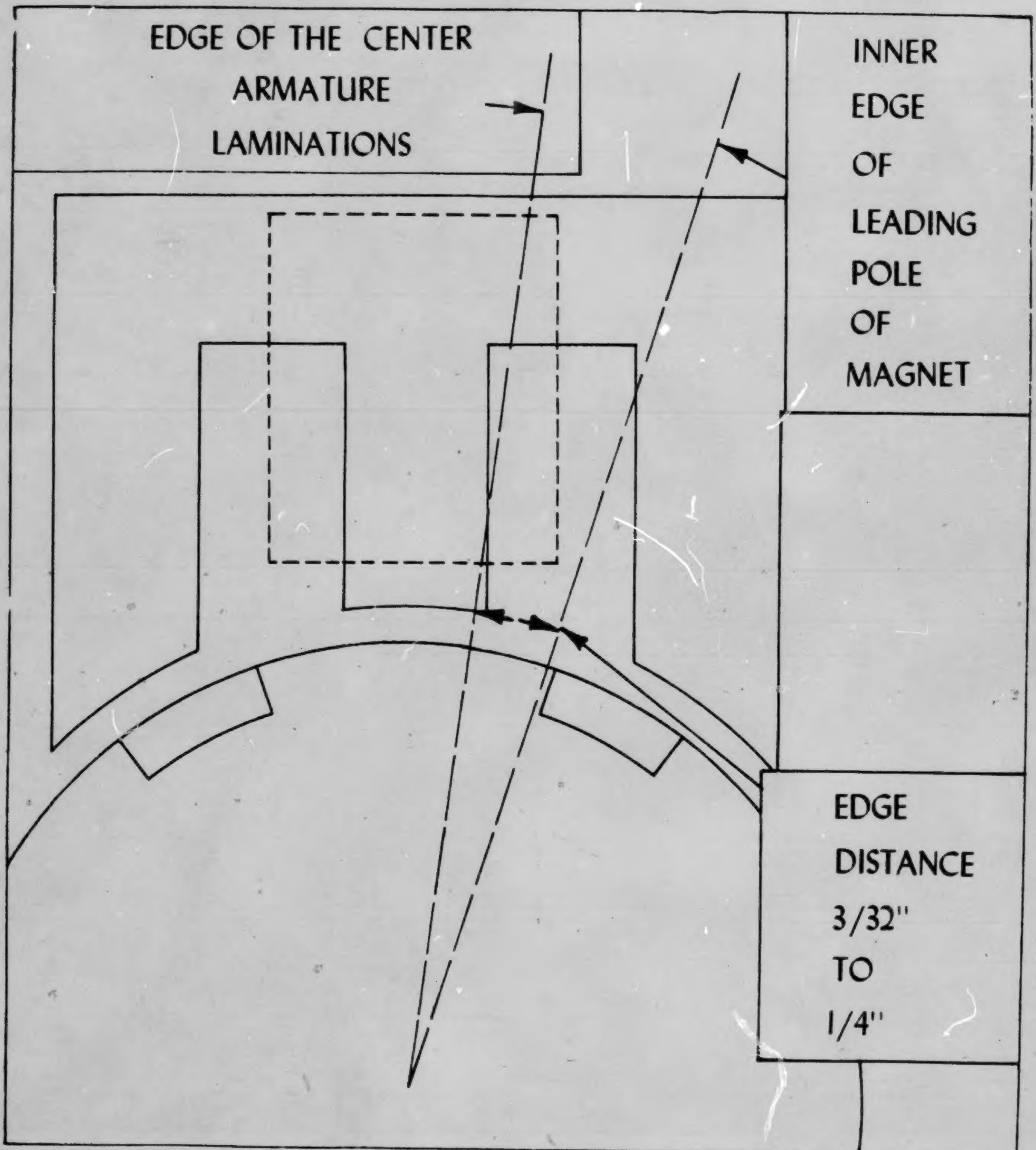
IV. Fuel problems

   A. No fuel in carburetor

   B. Flooding or starving

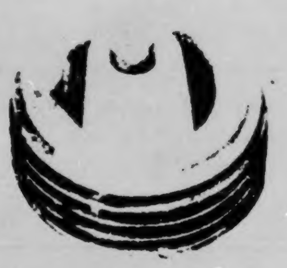
   C. Inadequate air supply

   D. Improper fuel mixture

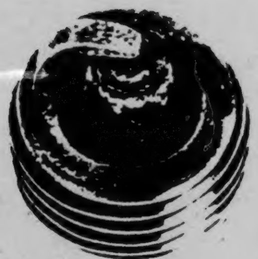

EDGE OF THE CENTER ARMATURE LAMINATIONS
INNER EDGE OF LEADING POLE OF MAGNET
EDGE DISTANCE 3/32" TO 1/4"

The spark is greatest if the points open when the center of the magnet is just past the center line of the coil. This distance is known as "edge distance."

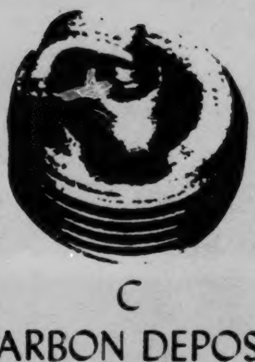
CONDITION OF SPARK PLUG



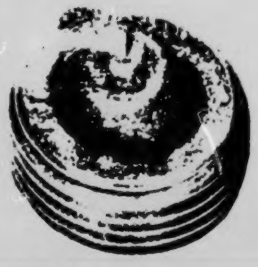
A
NORMAL WEAR



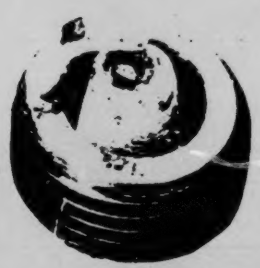
B
WORN OUT



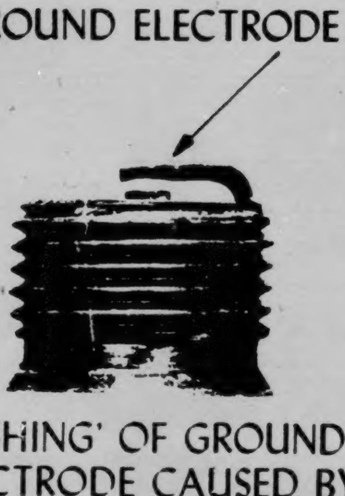
C
CARBON DEPOSITS



D
OIL DEPOSITS



E
OVERHEATED



'DISHING' OF GROUND ELECTRODE CAUSED BY REVERSE COIL POLARITY.

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

JOB SHEET NO. 1--TROUBLE SHOOTING IGNITION PROBLEMS
(Magneto/mechanical ignition system, no-run condition)

I. Tools and materials needed

   A. Small engine

   B. Spark tester (neon pencil type)

   C. Feeler gauge

   D. Socket set 3/8" drive

   E. Combination end wrenches

   F. Standard screwdriver

   G. Phillips screwdriver

II. Procedure

   A. Faulty or inadequate spark--check the following:

      1. Hold spark plug wire about 1/8" from cylinder head (away from spark plug) and a good strong spark should jump the gap to the ground. Make sure kill button is not on.

      2. If the spark is not sufficient, obtain a spark tester and test spark. (Following instructions provided by the manufacturer of the tester.)

      3. Check the spark plug wire for worn insulation or other causes of shorts.

      4. Check points for proper clearance. (See service manual for procedures and specifications.)

      5. Check points for corrosion or foreign matter.

      6. Check magneto, coil, and condenser. (See Job Sheet)

      7. Check magneto air gap on flywheel. (Set to specifications)

JOB SHEET NO. 1

8. Check point plunger or cam to insure proper operation.

9. Check flywheel key, it may be sheared.

B. Dirty or defective spark plug.

1. Steps to checking spark plug.

   a. Remove wire.

   b. Loosen plug one or two turns and then remove dirt, grease, or other foreign matter with a brush, compressed air, or upsetting the engine.

   c. Finish removing the plug.

   d. Remove the gasket if it should happen to remain on the head.

   e. Reconnect the plug wire and ground the plug to the engine. (Must be an unpainted surface.)

   f. Crank the engine one or two turns and observe the spark at the electrode. If the plug is good, it will have a blue-orange color with multi-lines and a sharp cracking sound. If the plug checks good, reinstall using proper torque specifications.

   g. If plug is not good--check the condition of the plug. See TM-2. If plug is damaged or faulty beyond repair--then replace. If plug can be serviced then:

      (1) Remove oil deposits.

      (2) Clean threads with a wire brush. (Do Not brush the insulator.)

      (3) Remove carbon deposits from plug with a thin bladed knife.

      NOTE: If a sand blasting plug cleaner is used for step 3--Be sure to remove *all sand* from around electrode of plug. (Some engine manufacturers void the warranty on an engine if plugs are cleaned with a sand-blasting machine.)

      (4) After cleaning plug--use an ignition point file to file both electrode surfaces of the plug. File until both surfaces are flat. (It takes 25% to 40% less voltage to fire a properly filed plug.)

      (5) Set the gap to proper specifications.

      (6) Reinstall the plug in the engine using proper torque specifications.

JOB SHEET NO. 1

C. Improper ignition timing. (If steps 1-9 do not correct the spark problem, then check the magneto timing as follows. NOTE: This setting is called "edge distance." See TM-1. The center line of the rotating magnet should be just past the center line of the starter plate when the piston is at the desired position for ignition to take place.)

D. Faulty ignition wiring (secondary).

   1. Place spark tester on the wire as closely to, or adjacent to, the spark plug as possible.

   2. Spark tester illumination indicates sound secondary ignition wiring.

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

JOB SHEET NO. 2--MAGNETO COIL-CONDENSER TESTER

I. Tools and materials needed.

A. Coil-condenser tester, King Model 603, or equivalent.

B. Small engine with coil and condenser.

C. Coils and condensers of known quality or capacity.

D. References to determine manufacturer's specifications for coils and condensers to be tested.

II. Procedure.

A. Remove coil and condenser from engine or connect all leads except ground.

B. Inspect coil and condenser for physical damage and loose connections.

C. Connect coil-condenser tester to power.

D. Coil testing - Determine type and number of coil. Connect to coil as shown in Figure A.

E. Adjust COIL SET to calibration index using good coil or according to coil set by manufacturers. Coil Set ________________________________.

F. Place SELECTOR in COIL position.

G. Read meter on coil or upper scale. If coil is good a minimum meter reading of 5 must be obtained. Meter reading ________________________.

H. Move switch to OFF, disconnect leads.

I. Condenser Testing - determine type and make of condenser. Manufacturer's specifications for capacity limits, MFD ____________________.

J. Connect tester primary leads to condenser shown in Figure B.

K. Move switch to MFD position.

L. Read meter on MFD. Reading in MFD ____________________.

M. A full scale reading indicates a shorted or leaking condenser, a zero reading indicates an open condenser.

JOB SHEET NO. 2

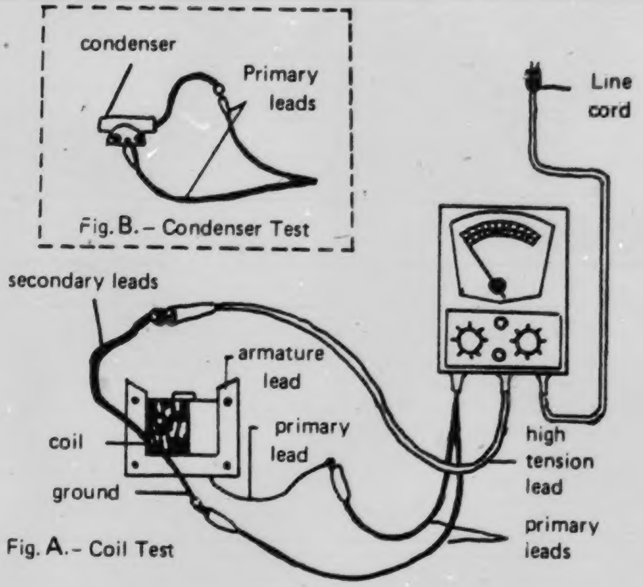
N. Place selector on TEST for leakage test. A good condenser will take an initial charge noted by a single flash in the neon lamp. Leaky condensers will be noted by a constant glow or flashing on or off.

O. Move switch to OFF, disconnect leads.

P. Condenser evaluation (good-fair-poor).

Q. Reconnect coil and condenser, if needed replace with new coil or condenser.

II. Diagram of Procedure.


condenser
Primary leads
Fig. B. – Condenser Test
Line cord
secondary leads
armature lead
coil
primary lead
ground
high tension lead
primary leads
Fig. A. – Coil Test

COIL–CONDENSER TESTER

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

JOB SHEET NO. 3--TROUBLE SHOOTING COMPRESSION PROBLEMS
(No-run condition, confirmed ignition system is sound)

I. Tools and materials needed

- A. Small engine
- B. Soap and water
- C. Combination end wrenches
- D. Spark plug wrench
- E. Compression tester/gauge set
- F. Engine oil
- G. Socket set 3/8"

II. Procedure

- A. Faulty cylinder head.
  1. Crank the engine and listen for air escaping at the cylinder head. Look for burned spots that are evidences of leaks especially in head gasket area.
  2. Apply soapy water mixture to seal area between head and block--and watch for air bubbles to identify a leak.

JOB SHEET NO. 3

B. Compression test procedure

1. Obtain compression tester/gauge set.
    a. Select proper gauge adapter based on size and configuration of engine spark plug hole.
2. Remove spark plug from engine
3. Ground spark plug wire for safety.
4. Insert compression tester/gauge adapter into spark plug hole.
5. Hold tester/gauge firmly and squarely into spark plug hole.
6. Crank engine a minimum of four to six strokes with throttle in full open position.
7. Remove tester/gauge and record reading.
8. Repeat test and compare test results. (If reading is at least 75% of specification, the engine should start and run but may be rough running or unable to produce expected power.)
9. Excessively high compression--10-20 percent above specifications indicates abnormal accumulation of combustion chamber deposits.

C. Low compression results

1. Worn rings

JOB SHEET NO. 3

- a. Remove spark plug.
- b. Pour approximately one tablespoon of oil into cylinder.
- c. Crank engine several times while spark plug is removed.
- d. Replace spark plug
- e. Check compression again--if compression increases from original test, poor piston rings and/or cylinder wear are likely.

2. Faulty valves

- a. Confirmation (if piston rings check out with above test, faulty valves may be suspected).
- b. Open throttle wide.
- c. Ground ignition or make sure in off position.
- d. Listen for cylinder leakage during slow cranking cycle.
- e. If compression is low--it may be necessary to provide artificial air pressure.
- f. Crank engine so that piston is on top dead center.
- g. Apply regulated air into spark plug hole. The compression tester/gauge adapter may be used on end of air nozzle to help "trap" the air in cylinder.
- h. Regulate air pressure to avoid moving the cylinder off of top dead center.
- i. DO NOT USE FULL LINE AIR PRESSURE IN THIS PROCEDURE.
- j. Listen for escaping air at carburetor during slow cranking or application of external air pressure to the combustion chamber.
- k. If air escaping--indicates a leaking intake valve.
- l. Escaping air heard at the muffler (exhaust outlet) indicates a leaking exhaust valve.

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

JOB SHEET NO. 4--TROUBLE SHOOTING FUEL PROBLEMS
(Engine poor run/no-run condition. Ignition
and mechanical tests positive.)

I. Tools and materials needed

   A. Small engine with gravity feed carburetor

   B. Small engine with suction feed carburetor

   C. Combination end wrenches

   D. Standard screwdriver

   E. Phillips screwdriver

   F. Soda straw or teaspoon

   G. Socket set 3/8" drive

   H. Needle nose pliers

II. Procedure

   A. No fuel in carburetor--check the following:

      1. Fuel supply in tank.

      2. Fuel in line shutoff.

      3. Crimped flexible line.

      4. Plugged filter or line.

      5. Frozen water or moisture in system.

      6. Carburetor flat valve stuck or clogged.

      7. Fuel tank vent plugged.

      8. Overheating fo fuel line from tank to carburetor causing "vapor lock."

   B. Flooding or starving, check for the following problems.

      1. Choke stuck or overused.

      2. Float stuck open.

      3. Mixture too rich.

      4. High speed jet set too rich.

      5. Choke not closing.

      6. Intake manifold leak.

      7. Diaphram type carburetor not pumping fuel.

JOB SHEET NO. 4

8. Jets restricted.

9. Mixture set too lean.

10. Mixture set too rich.

11. Check if carburetor is delivering fuel to cylinder:

    a. Remove spark plug.

    b. Place your thumb over the plug hole and crank engine 3 or 4 revolutions. Your thumb should be wet with fuel if carburetor is delivering fuel.

12. Carburetor is not delivering fuel--check as follows:

    a. Using a soda straw or teaspoon--Add about 1 teaspoon of fuel directly into the carburetor and try to start the engine and if it starts, you know that fuel is not getting from the carburetor to the cylinder.

C. Inadequate air supply--check the following:

1. Dirty air cleaner.

2. Plugged or partially blocked air intake hose.

3. Improper adjustment of load jet valve.

4. Loose or leaking intake manifold and/or gasket.

5. Choke stuck or overadjusted causing excessing fuel for air allowed to enter.

D. Improper fuel mixture. (See Job Sheet.) Use the following general guidelines.

1. Check the exhaust smoke--black smoke--excessive fuel. (NOTE: 2 cycle engine should smoke slightly because of oil in fuel.)

JOB SHEET NO. 4

2. Allow engine to warm up, then advance throttle suddenly--the engine should accelerate smoothly and evenly. Uneven acceleration indicates the fuel mixture is too lean. Also high operating temperature indicates a lean mixture.

E. Carburetor malfunctioning

1. Gravity flow carburetor

   a. Check gas tank cap vent and check tank for sufficient gas.

   b. Open gas line shut-off valve.

   c. With properly serviced air cleaner in place, start engine and allow to warm up.

   d. Increase engine speed to manufacturer's recommended operating speed. ____________RPM

   e. Turn needle valve in until engine runs rough, turn needle valve back out until it runs rough again, then turn back in nearly ½ way. Turning the needle valve causes a ____________ mixture.

   f. Slow engine to manufacturer's recommended idle speed. ____________ RPM

   g. Turn idle needle in until engine runs rough, then back out until highest RPM and maximum smoothness are obtained.

JOB SHEET NO. 4

2. Suction feed carburetor

   a. Check vent hole in cap of tank.

   b. Fill tank ½ full.

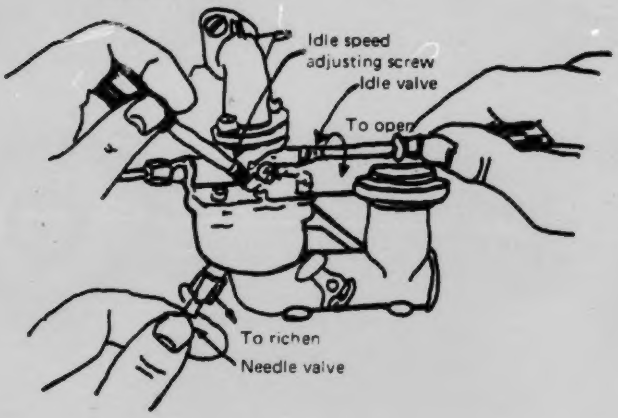
   c. Start engine and run at operating speed with properly serviced air cleaner in place and with choke fully closed. __________ RPM

   d. Turn needle valve in until engine runs rough, turn back out until engine just begins to run rough.

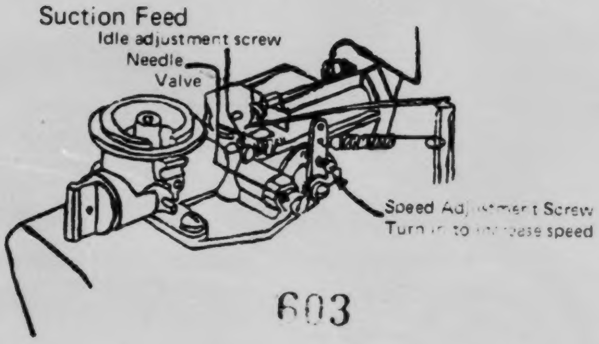
   e. Idle engine down and adjust idle speed to recommended __________ RPM using idle speed adjusting screw.

3. Diagram of procedure of carburetor adjustment.

Gravity Feed


Idle speed adjusting screw
Idle valve
To open
To richen
Needle valve

Suction Feed


Idle adjustment screw
Needle
Valve
Speed Adjustment Screw
Turn in to increase speed

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

TEST

1. Define the following terms:
    a. Trouble shooting
    b. Tune up
    c. Magneto-coil-condenser tester
2. Name four common causes of ignition problems.
    a.
    b.
    c.
    d.
3. Name four common compression problems.
    a.
    b.
    c.
    d.
4. Name four possible causes of fuel problems.
    a.
    b.
    c.
    d.
5. Demonstrate, to the satisfaction of the instructor, the ability to:
    a. Trouble shoot ignition problems.
    b. Use a magneto-coil-condenser tester.
    c. Trouble shoot compression problems
    d. Trouble shoot fuel problems.

TROUBLE SHOOTING OF SMALL ENGINES
UNIT VIII

ANSWERS TO TEST

1. a. Trouble shooting--The process of elimination involved in determining the part or parts malfunctioning in an engine.

   b. Tune up--The process of correcting minor malfunctioning problems in an engine.

   c. Magneto-coil-condenser tester--An instrument used to check the magneto-coil-condenser for proper operation.

2. Any four of the following:

   a. Faulty or inadequate spark.

   b. Faulty ignition wiring.

   c. Dirty or defective spark plug.

   d. Defective ignition points.

   e. Faulty coil.

   f. Faulty armature.

3. Any four of the following:

   a. Worn piston rings.

   b. Improperly adjusted valves.

   c. Faulty valves.

   d. Improper valve clearance.

   e. Faulty cylinder head.

   f. Faulty cylinder head gasket.

4. a. Inadequate supply.

   b. Flooding or starving.

   c. Inadequate air supply.

   d. Improper fuel mixture.

5. Performance skills will be evaluated by the instructor.

OXYACETYLENE BRAZE WELDING
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe the differences between braze welding and fusion welding and list advantages and disadvantages of braze welding. The student should also be able to describe the reaction when adding bronze to base metal that is too hot, too cold, or correct. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with brazing to the correct definitions.
2. List three advantages and three disadvantages of braze welding.
3. State in writing the importance of having a chemically clean metal surface in braze welding.
4. Select from a list methods for removing oxides from a clean metal surface.
5. Describe the differences between braze welding and fusion welding.
6. List five purposes for using flux.
7. Describe the reaction of molten bronze when the temperature of the base metal is too hot, too cold, and correct.
8. Demonstrate the ability to braze weld a square groove butt joint.

OXYACETYLENE BRAZE WELDING
UNIT IX

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparency.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedure outlined in the job sheet.

   (NOTE: The instructor may want to secure the film on braze welding from a local welding supplier or the Curriculum and Instructional Materials Center to show to the class.)

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedure outlined in the job sheet.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency master: TM 1--Braze Welding a Butt Joint

   D. Job Sheet #1--Braze Weld a Square Groove Butt Joint

E. Test

F. Answers to test

II. References:

A. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures*. New York: Union Carbide Corporation, Linde Division, 1960.

B. Althouse, Andrew D., Carl H. Quinquist, and William A. Bowditch. *Modern Welding*. Homewood, Illinois: Goodheart-Wilcox Company, Inc., 1965.

C. Giachino, J. W., William Weeks, and Elmer Brune. *Welding Skills and Practices*. Chicago, Illinois: American Technical Society, 1967.

III. Filmstrip— "Oxy-acetylene Part I and Part II." San Luis Obispo, California: California State Polytechnic College.

OXYACETYLENE BRAZE WELDING
UNIT IX

INFORMATION SHEET

I. Terms and definitions

A. Braze welding--Heating the base metal to a dull red color and depositing a head over the seam (joint) with a bronze filler rod; the base metal is not melted (Transparency 1)

B. Malleability--Property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

C. Ductile--Capable of being drawn or stretched out

D. Tinning operation--Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

(NOTE: It is this flow of the thin film of bronze which is known as *tinning.*)

E. Flux--Chemical used to clean metals and to promote fusion during the welding process

II. Advantages and disadvantages of braze welding

A. Advantages

1. Provides less chance of destroying main characteristics of base metal since it is not heated to a molten condition
2. Consumes less gas
3. Can be used on thin metals
4. Used on malleable castings
5. Increases speed of joining metals
6. May be used to join different kinds of metals

B. Disadvantages

1. Cannot be used on metal where stress is a factor
2. Bronze rod is expensive to use
3. Not recommended for parts which are raised to temperatures higher than the melting point of bronze, either in service or during heat treatment

INFORMATION SHEET

E. Increase the ability of filler metal to adhere to the base metal

F. Bring the filler metal into immediate contact with metals being joined

G. Permit the filler metal to penetrate the pores of the base metal

VII. Reaction of molten bronze at different temperatures

A. Too hot--The molten bronze will tend to boil and form little balls

B. Too cool--The molten bronze will form into drops rather than flowing evenly over the surface

C. Correct--The molten bronze will spread evenly and flow over a considerable area

INFORMATION SHEET

4. Bronze will lose its strength at temperatures above 500°F
5. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

III. Importance of a chemically clean surface in braze welding

A. Ensure the molten bronze will stick to the base metal

B. Have a stronger bond on base metal

C. Allow bronze to flow smoothly and evenly over entire weld area

IV. Methods for removing oxides

A. Mechanical means

1. Wire brush
2. Grinder

B. Chemical means--Flux

(NOTE: Both methods should be used to completely remove the oxides.)

V. Differences between braze welding and fusion welding

A. Braze welding

1. Base metal is not melted

   (NOTE: Base metal is heated only to a dull red color.)

2. An alloy rod is used to lay a thin coat of bronze along the seam

B. Fusion welding

1. Base metal is melted and joined
2. Rod with similar characteristics of base metal must be used

VI. Purposes for using flux

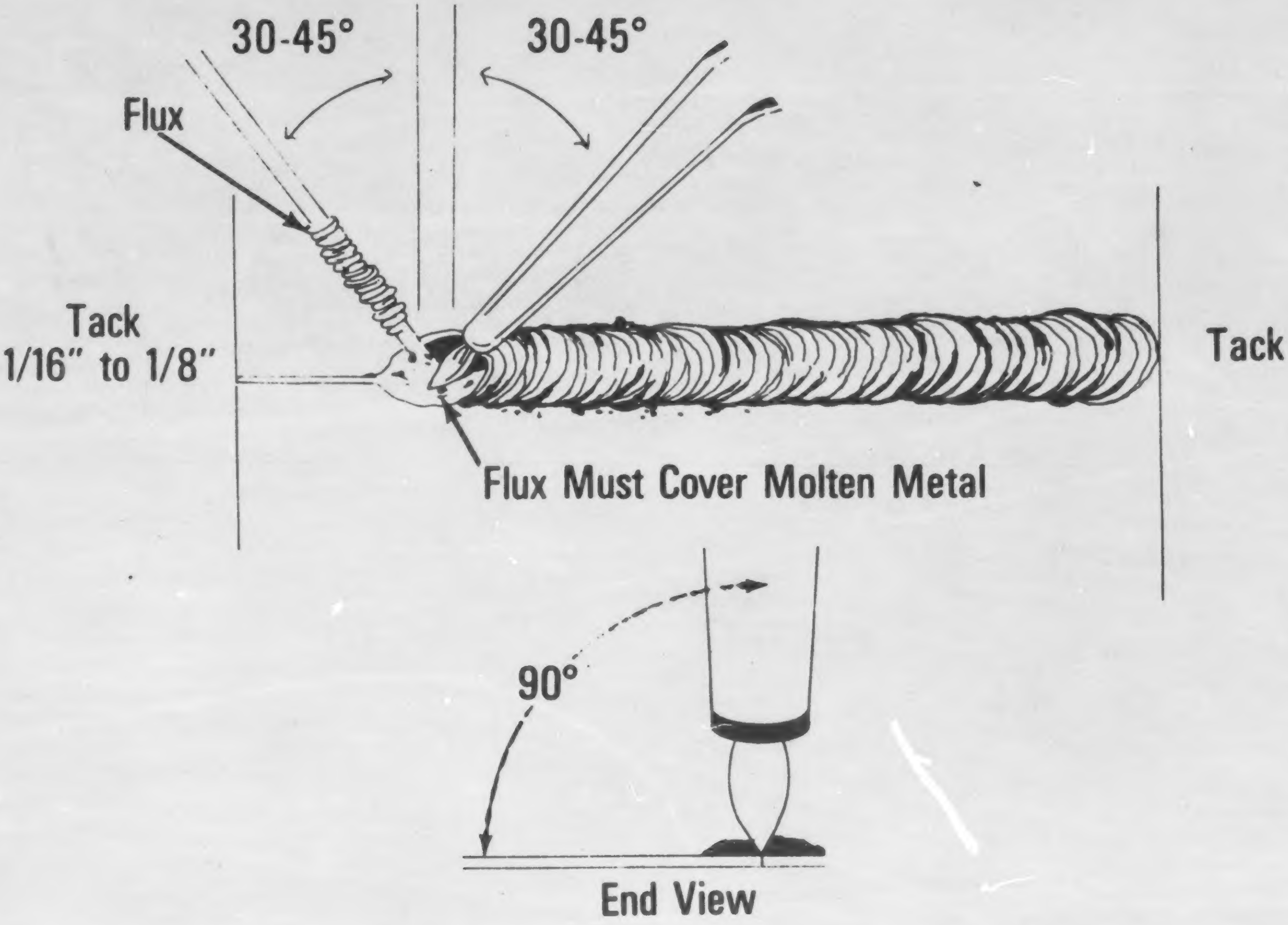
A. Clean the base metal chemically

B. Prevent oxidation of filler metal

C. Float and remove oxides already present

D. Increase flow of filler metal

Braze Welding A Butt Joint


30-45°
30-45°
Flux
Tack
1/16" to 1/8"
Tack
Flux Must Cover Molten Metal
90°
End View

612

613

TM 1

AM-297-B

OXYACETYLENE BRAZE WELDING
UNIT IX

JOB SHEET #1--BRAZE WELD A SQUARE GROOVE BUTT JOINT

I. Tools, equipment, and materials

- A. Oxyacetylene welding unit
- B. Gloves
- C. Safety glasses
- D. Goggles
- E. Welding tip (according to manufacturer's recommendations.)
- F. Wire brush
- G. Flint lighter
- H. Fire brick
- I. Mild steel, 2 strips 1/8" thick, 1 1/4" x 6"
- J. Bronze filler rod (use according to manufacturer's recommendations)
- K. Welding flux

III. Procedure

- A. Clean metal
- B. Place metal in brazing position, 1/16" to 1/8" apart
- C. Turn on oxyacetylene unit
- D. Adjust proper working pressure of oxygen and acetylene (use manufacturer's recommendations)
- E. Place metal on fire brick

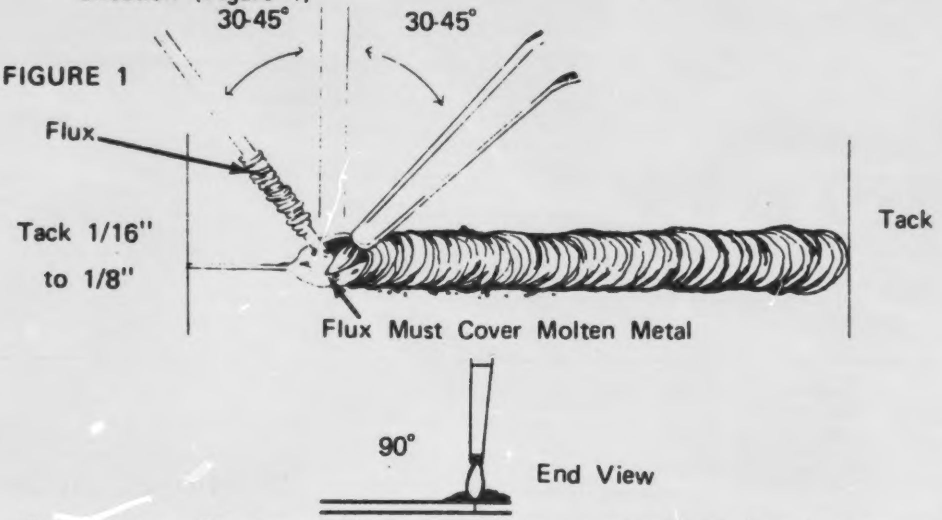
  (NOTE: Do not lay metal flat on brick. Arrange metal so a small space will be between the base metal and the fire brick.)
- F. Light and adjust torch to a neutral or slightly oxidizing flame
- G. Preheat the end of the brazing rod and dip in the flux or use fluxed rod
- H. Tack metal in place using braze filler metal

JOB SHEET #1

I. Heat the surface of the weld area slightly

J. Hold torch 30° to 45° vertically; hold filler rod at same angle in opposite direction (Figure 1)

FIGURE 1


30-45°
30-45°
Flux
Tack 1/16" to 1/8"
Tack
Flux Must Cover Molten Metal
90°
End View

K. Melt a small amount of bronze rod onto the surface and allow it to spread along the entire seam when a cherry red color occurs

L. Start depositing the proper size bead when the base metal is tinned sufficiently

(NOTE: When metal is not hot enough, the bronze will form into drops; when metal is too hot, bronze tends to boil.)

M. Complete the weld and practice doing other welds

N. Inspect weld; then check with instructor

OXYACETYLENE BRAZE WELDING
UNIT IX

TEST

1. Match terms on the right to the correct definition.

_____a. Capable of being drawn or stretched out

_____b. Chemical used to clean metals and to promote fusion during the welding process

_____c. Property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

_____d. Heating the base metal to a dull red color and depositing a head over the seam (joint) with bronze filler rod; the base metal is not melted

_____e. Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

1. Flux
2. Braze welding
3. Malleability
4. Tinning operation
5. Ductile

2. List three advantages and three disadvantages of braze welding.

a. Advantages

1)

2)

3)

b. Disadvantages

1)

2)

3)

3. State in writing the importance of having a chemically clean metal surface in braze welding.

4. Select from the list below methods for removing oxides from a clean metal surface by placing an "X" in the blank.

_____a. Wire brush

_____b. Hammer

_____c. Acid

_____d. Grinder

_____e. Flux

_____f. Water

5. Describe the differences between braze welding and fusion welding.

6. List five purposes for using flux.

   a.

   b.

   c.

   d.

   e.

7. Describe the reactions of molten bronze when the temperature is:

   a. Too hot

   b. Too cool

   c. Correct

8. Demonstrate the ability to braze weld a square groove butt joint.

   (NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)

OXYACETYLENE BRAZE WELDING
UNIT IX

ANSWERS TO TEST

1. a. 5
   b. 1
   c. 3
   d. 2
   e. 4

2. Any three from each group:

   a. Advantages

      1. Provides less chance of destroying main characteristics of base metal since it is not heated to a molten condition
      2. Consumes less gas
      3. Can be used on thin metals
      4. Used on malleable castings
      5. Increase speed of joining metals
      6. May be used to join different kinds of metals

   b. Disadvantages

      1. Cannot be used on metal where stress is a factor
      2. Bronze rod is expensive to use
      3. Not recommended for parts which are raised to temperatures higher than the melting point of bronze, either in service or during heat treatment
      4. Bronze will lose its strength at temperatures above 500°F
      5. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

3. Discussion should include:
    a. Ensure the molten bronze will stick to the base metal
    b. Have a stronger bond on base metal
    c. Allow bronze to flow smoothly and evenly over entire weld area
4. a, d, e
5. Description should include:
    a. Braze welding
        1. Base metal is not melted
        2. An alloy rod is used to lay a thin coat of bronze along the seam
    b. Fusion welding
        1. Base metal is melted and joined
        2. Rod with similar characteristics of base metal must be used
6. Any five of the following:
    a. Clean the base metal chemically
    b. Prevent oxidation of filler metal
    c. Float and remove oxides already present
    d. Increase flow of filler metal
    e. Increase ability of filler metal to adhere to the base metal
    f. Bring the filler metal into immediate contact with metals being joined
    g. Permit the filler metal to penetrate the pores of the base metal
7. Description should include:
    a. Too hot--The molten bronze will tend to boil and form little balls
    b. Too cool--The molten bronze will form into drops rather than flowing evenly over the surface
    c. Correct--The molten bronze will spread evenly and flow over a considerable area
8. Performance skills evaluated to the satisfaction of the instructor.

ARC WELDING
UNIT X

UNIT OBJECTIVE

After completion of this unit, the student should be able to select kinds of arc welders and equipment needed and list safety precautions observed in arc welding. The student should also be able to strike an arc, run a bead, and construct a butt weld. This knowledge will be evidenced through actual demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with arc welding to the correct definition.
2. List five safety precautions used in arc welding.
3. List two kinds of arc welders.
4. Select from a list common equipment used in arc welding.
5. List four types of electrodes.
6. Select from a list the two most common sizes of electrodes used in agricultural mechanics.
7. Identify the meaning of the numbers in the electrode classification system.
8. Name two methods of coating electrodes.
9. List three purposes of electrode coating.
10. Describe the effect of raising and lowering the arc welding current.
11. Name two methods of establishing an arc.
12. Select from a list characteristics of proper arc length.
13. Label the parts of a drawing associated with the welding process.
14. Identify three kinds of welds.
15. Identify five types of weld joints.
16. List four welding positions.
17. List four reasons for poor welds.

18. Demonstrate the ability to:
    a. Start, stop, and restart a bead.
    b. Construct a pad weld.
    c. Construct a butt weld.

ARC WELDING
UNIT X

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Students:

   A. Read objectives.

   B. Study information sheet and take notes.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--AWS Classification of Electrodes

      2. TM 2--Welding Process

3. TM 3--Kinds of Welds
4. TM 4--Types of Weld Joints
5. TM 5--Welding Positions

D. Job sheets

1. Job Sheet #1--Start, Stop, and Restart a Bead
2. Job Sheet #2--Construct a Pad Weld
3. Job Sheet #3--Construct a Butt Weld

E. Test

F. Answers to test

II. References:

A. Jones, M. M. *Shopwork on the Farm.* New York: McGraw-Hill Company, 1955.

B. Phipps, Lloyd J. *Mechanics in Agriculture.* Danville, Illinois: Interstate Printers and Publishers, Inc., 1967.

C. Kugler, Harold L. *ARC Welding Lessons for School and Farm Shop.* Cleveland, Ohio: The James F. Lincoln Arc Welding Foundation, 1964.

D. Hallenberg, A. H. *How to Teach Arc Welding in Farm Mechanics.* Cleveland, Ohio: The James F. Lincoln Arc Welding Foundation, 1958.

E. *Hobart Welding School Workbook.* Troy, Ohio: Hobart Brothers Technical Center.

ARC WELDING
UNIT X

INFORMATION SHEET

I. Terms and definitions (Transparencies 2 and 3)

   A. Arc--Flow of current across a narrow gap

   B. Base metal--Metal to be welded

   C. Bead weld--Made by one pass of the electrode

   D. Bevel--Type of edge preparation

   E. Butt joint--Weld between two metal parts on the same plane

   F. Crater--Depression at the end of weld

   G. Electrode--Metal rod which conducts a current from the electrode holder to the base metal

   H. Welding--Joining of two or more pieces of metal together by the fusion process

   (NOTE: In arc welding, heat is produced by the electric arc.)

   I. AWS--American Welding Society

II. Safety precautions in arc welding

   A. Never look at the arc with the naked eye

   B. Use a head or face shield that is in good condition

   C. Wear suitable clothing to protect all parts of the body

   Examples:
   1. Long sleeved shirt
   2. Leather gloves
   3. Collar buttoned
   4. Cuffs turned down
   5. High topped shoes or boots

   D. Do not strike an arc or weld until you are sure those in the vicinity have protective equipment or will look in the other direction

   (NOTE: Yell "cover" before striking an arc.)

INFORMATION SHEET

E. Do not weld around combustible or flammable materials

F. Do not pick up hot metal

G. Do not weld in confined places without ventilation

H. Always open main switch or disconnect plug when checking over a welder

I. Do not leave electrode holder on welding table or in contact with grounded metal

J. Do not use worn or frayed cables

K. Stand on dry footing when welding

L. Keep area around welder clean

M. Keep tools and metals in proper location

III. Kinds of arc welders

A. A.C.--(Alternating current) Welder current alternates direction 120 times per second

B. D.C.--(Direct current) Welder current flows in the same direction

C. TIG--(Tungsten Inert Gas) Welder may use either A.C. or D.C. with a nonconsumable tungsten electrode and an inert shielding gas

D. MIG--(Metal Inert Gas) May use A.C. or D.C. with a base wire filler material that is fed automatically into weld; also has an inert shielding gas

IV. Common arc welding equipment

A. Welder

B. Electrode holder with lead

C. Ground clamp with lead

D. Shield or helment

E. Gloves

F. Chipping hammer

G. Safety goggles

INFORMATION SHEET

- H. Wire brush
- I. Electrodes

V. Types of electrodes

- A. Mild steel
- B. High carbon steel
- C. Hard surfacing
- D. Alloys--Special purpose

VI. Common sizes of electrodes used in agricultural mechanics

- A. 1/8"
- B. 5/32"

  (NOTE: Sizes of electrodes range from 1/16" to 3/8". Electrode size is determined by the diameter of the wire.)

VII. Meaning of numbers in the electrode classification system (Transparency 1)

- A. E--Arc welding electrode
- B. 60-Tensile strength in thousand of pounds per square inch
- C. 1--Position to be used
- D. 1--Special characteristics

VIII. Methods of coating electrodes

- A. Wrapping
- B. Dipping

  (NOTE: Electrodes are dipped into a liquid flux solution.)

- C. Extruding

  (NOTE: This is the most common method.)

IX. Purposes of electrode coating

- A. Stabilizes the arc
- B. Shields molten puddle from air

INFORMATION SHEET

C. Floats impurities out of puddle

D. Forms slag and slows cooling

E. Increases speed and improves quality of weld

X. Effect of raising and lowering current

A. Raising current--Produces more heat

B. Lowering current--Produces less heat

(NOTE: On thicker metals more heat is necessary in order to get penetration.)

XI. Methods of establishing an arc

A. Scratching (similar to striking a match)

B. Tapping

XII. Characteristics of proper arc length

A. End of electrode is the same distance from the base metal as the diameter of electrode

Example: 1/8" electrode--arc length 1/8"

B. Correct arc length makes a steady hum of the welder and a "frying" sound at the arc

XIII. Parts of the welding process (Transparency 2)

A. Electrode

B. Wire core

C. Coating (flux)

D. Arc

E. Gaseous shield

F. Weld

G. Slag

H. Heat lines

I. Base metal

J. Penetration

K. Crater

INFORMATION SHEET

- L. 15°-30°
- M. Direction of travel

XIV. Kinds of welds (Transparency 3)

- A. Fillet
- B. Groove
- C. Bead

XV. Types of weld joints (Transparency 4)

- A. Edge joint
- B. Butt joint
- C. Corner joint
- D. T joint
- E. Lap joint

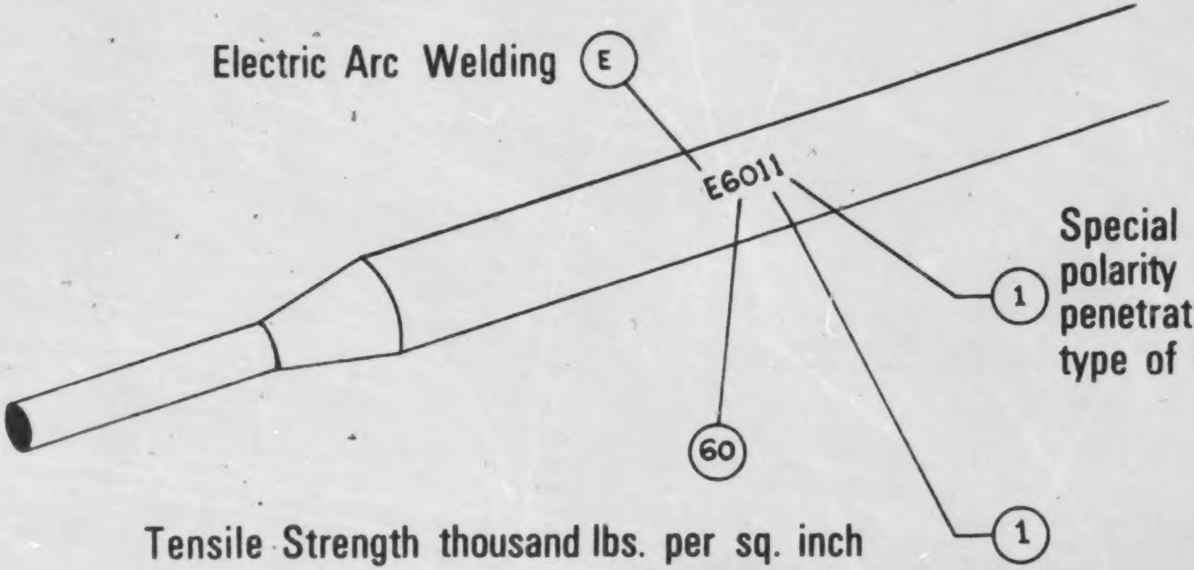
XVI. Weld positions (Transparency 5)

- A. Flat
- B. Vertical
- C. Overhead
- D. Horizontal

XVII. Reasons for poor welds

- A. Machine adjustment too hot or too cold
- B. Electrode size too large or too small
- C. Improper movement of electrode
- D. Improper angle of holding electrode
- E. Improper base metal preparation
- F. Arc length too long or too short

AWS Classification of Electrodes



Electric Arc Welding

Special char.
polarity
penetration
type of welder

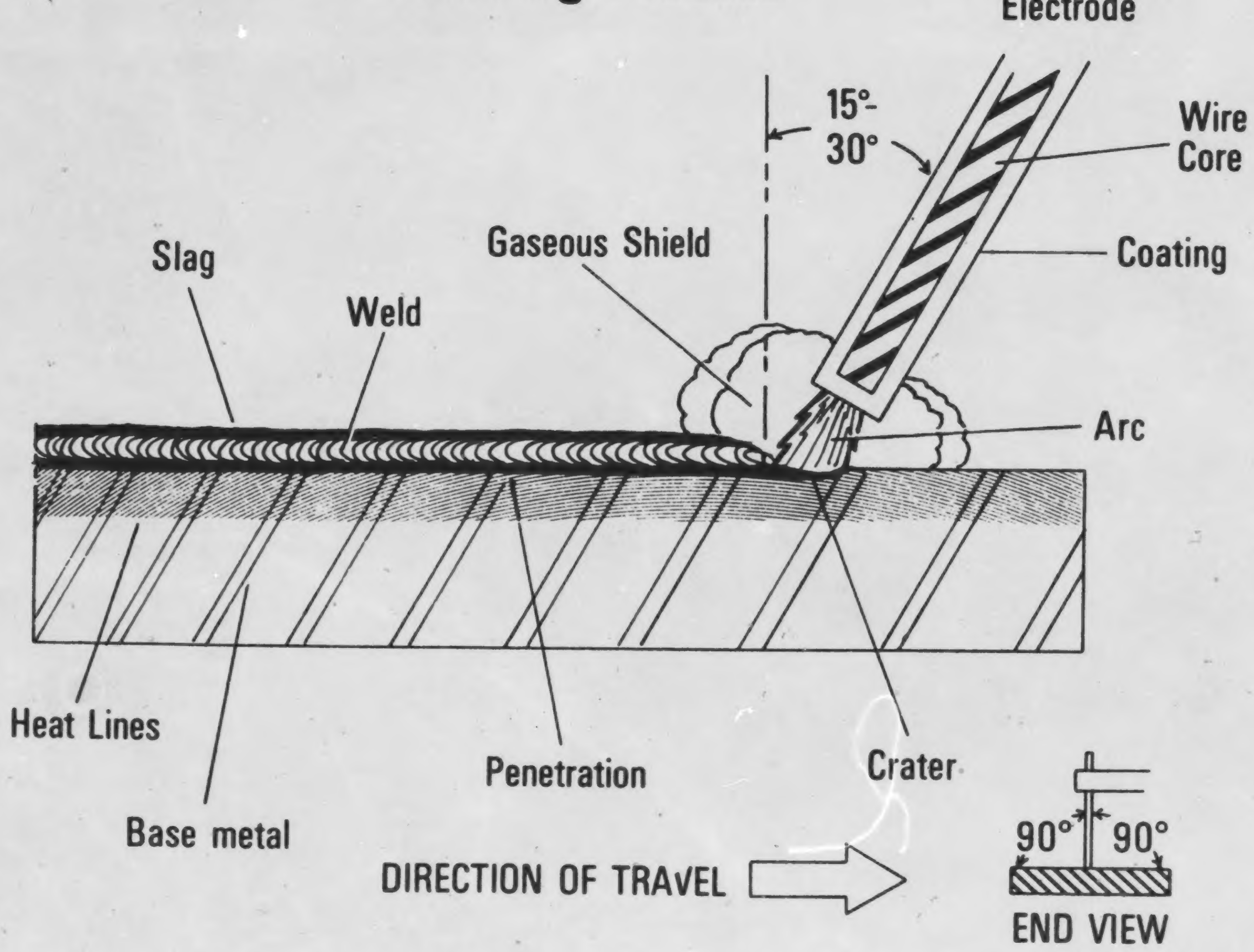
Tensile Strength thousand lbs. per sq. inch

Welding Position

1. all positions
2. flat and horizontal
3. flat

E6011 MILD STEEL ELECTRODE

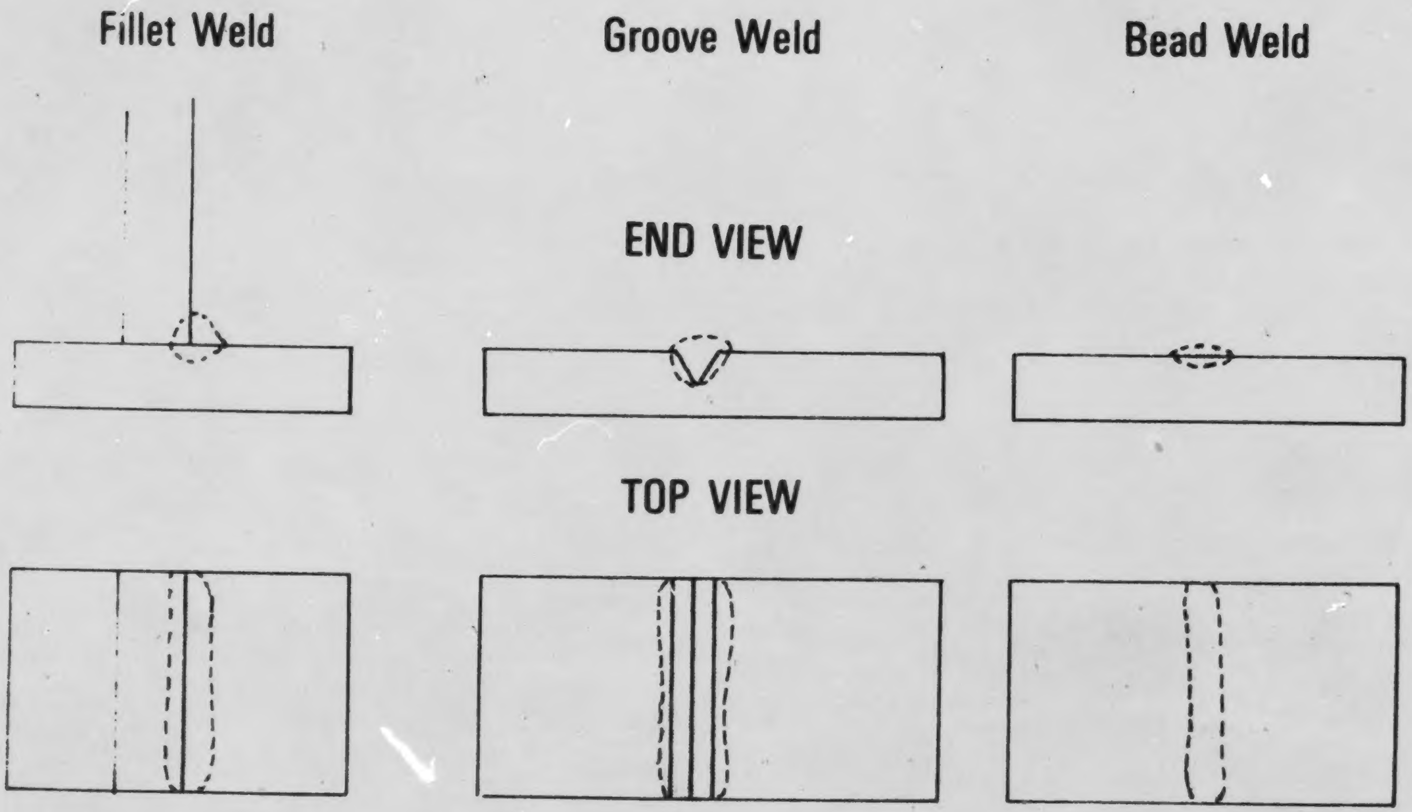
Welding Process


Electrode
15°-
30°
Wire
Core
Gaseous Shield
Coating
Slag
Weld
Arc
Heat Lines
Penetration
Crater
Base metal
90°
90°
DIRECTION OF TRAVEL
END VIEW

TM 2

AM-319-B

Kinds of Welds



Fillet Weld

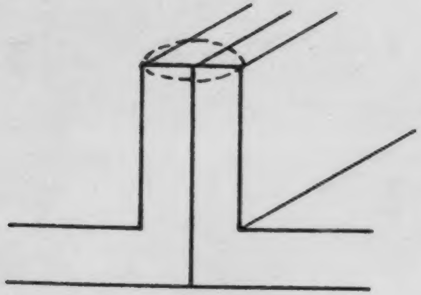
Groove Weld

Bead Weld

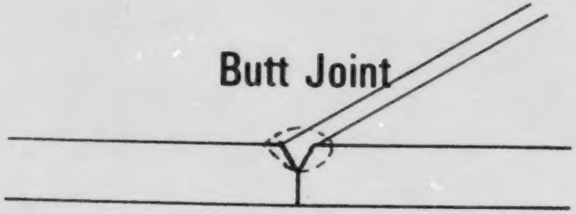
END VIEW

TOP VIEW

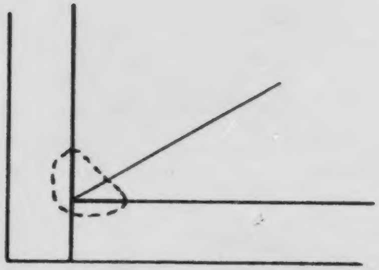
Types of Weld Joints



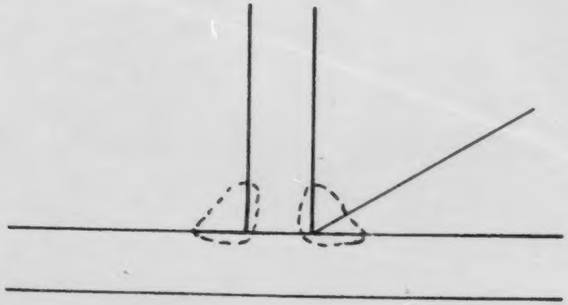
Edge Joint



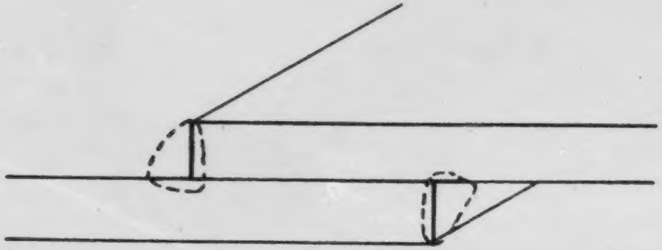
Butt Joint



Corner Joint

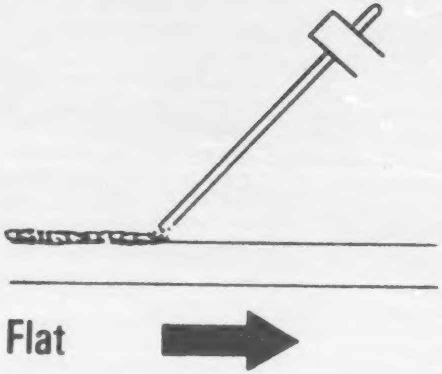


T Joint

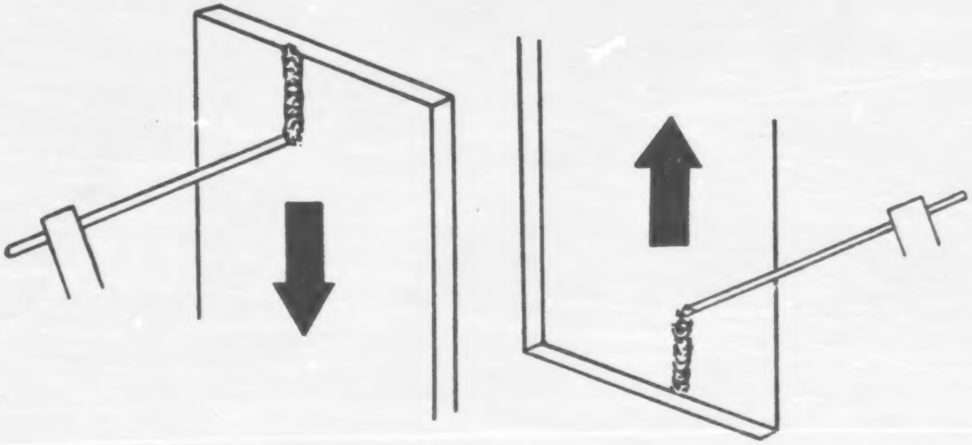


Lap Joint

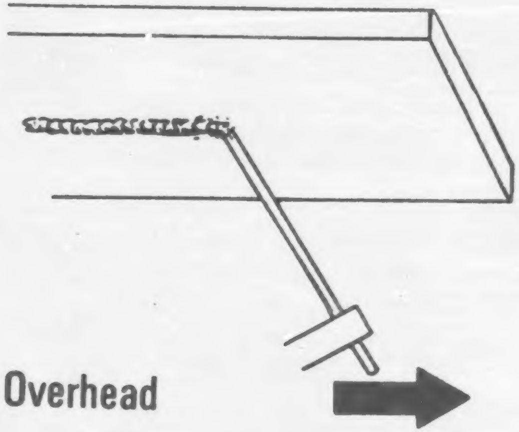
Welding Positions



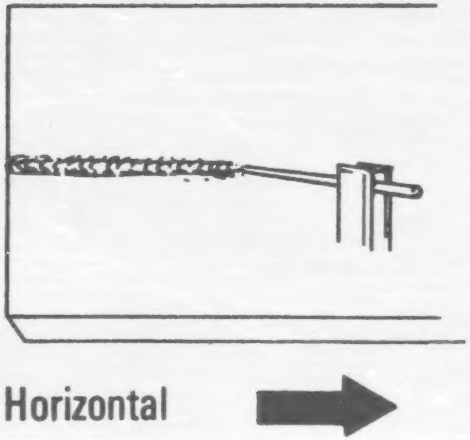
Flat



Vertical



Overhead



Horizontal

ARC WELDING
UNIT X

JOB SHEET #1--START, STOP, RESTART A BEAD

I. Equipment, materials, and tools needed

- A. Piece of metal 1/4" to 3/8" thick, 4" x 4"
- B. Welder
- C. Electrode holder and lead
- D. Ground clamp and lead
- E. Helmet
- F. Gloves
- G. Electrodes
- H. Safety goggles
- I. Chipping hammer
- J. Wire brush

II. Procedure

- A. Prepare metal for welding
- B. Strike arc 1" from edge where bead is to begin (Figures 1 and 2)

FIGURE 1

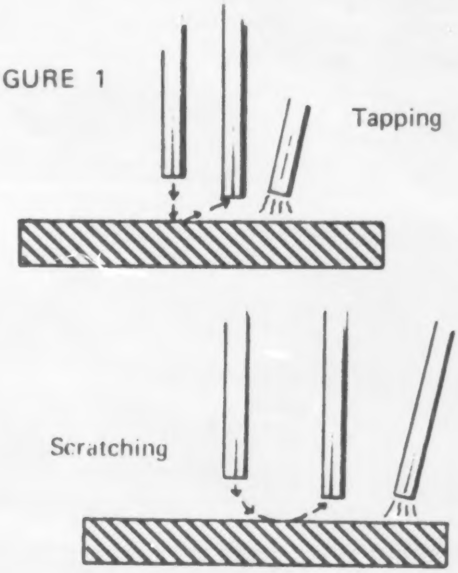
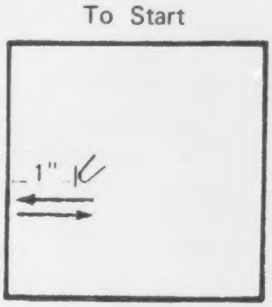


FIGURE 2



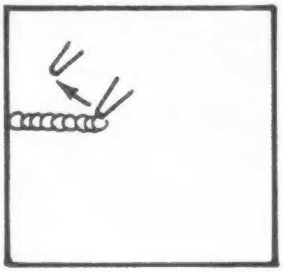
JOB SHEET #1

C. When arc burns brightly, move to edge maintaining the correct arc length and begin forming the puddle

D. Move across metal two inches

E. To stop bead, move electrode back through the puddle and lift up (Figure 3)

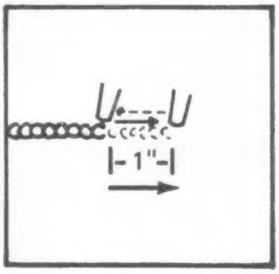
FIGURE 3 To Stop



(NOTE: This will prevent cracks from forming in the puddle.)

F. To restart, strike arc about 1" in front of crater (Figure 4)

FIGURE 4 To Restart



G. Move back through the crater when arc burns brightly and then resume the bead

(NOTE: This is necessary in order for beads to blend with one another without a change in continuity.)

ARC WELDING
UNIT X

JOB SHEET #2--CONSTRUCT A PAD

I. Equipment, tools, and material needed

   A. Piece of metal 1/4" to 3/8" thick, 4" x 4"

   B. Welder

   C. Electrode holder and lead

   D. Ground clamp and lead

   E. Helmet

   F. Gloves

   G. Electrodes

   H. Safety goggles

   I. Chipping hammer

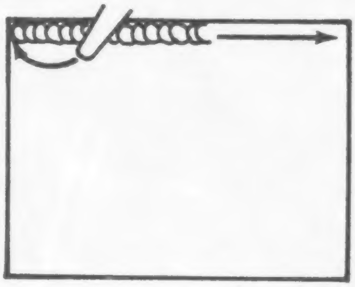
   J. Wire brush

II. Procedure

   A. Prepare metal for welding

   B. Strike arc and move to point to begin pad (Figure 1)

FIGURE 1



   C. Lay a straight bead across the plate using a weaving motion

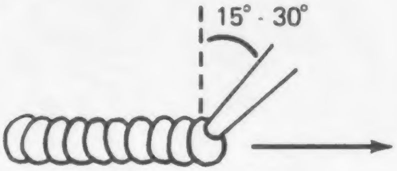
   (NOTE: In using E6011 electrode, it is necessary to use some type of rod manipulation in running a bead.)

JOB SHEET #2

D. Hold electrode at a 15° to 30° angle in direction of travel and lower electrode as rod burns away to maintain correct arc length (Figure 2)

(NOTE: There should be 90° on each side of the electrode.)

FIGURE 2

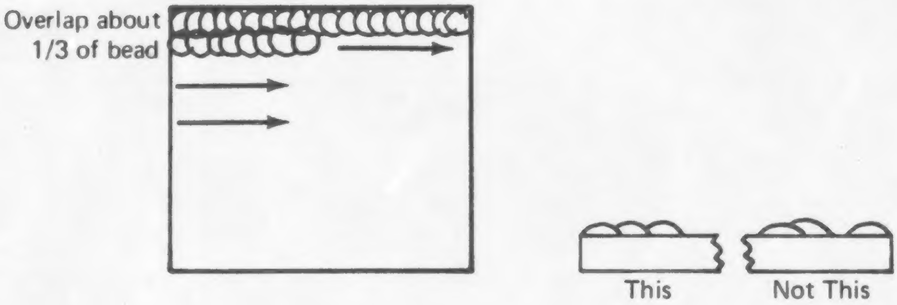


E. Move electrode steadily from right to left across pad

F. Clean the slag from each bead before starting the next one

G. Run beads until pad is full overlapping each bead (Figure 3)

FIGURE 3



H. Let each bead cool until slag is black before chipping

I. Run additional layers until desired thickness is obtained

ARC WELDING
UNIT X

JOB SHEET #3--CONSTRUCT A BUTT WELD

I. Equipment, tools, and materials needed

  A. Two pieces of metal, 1/4" to 3/8" thick, 3" x 6"

  B. Welder

  C. Electrode holder with leads

  D. Ground clamp with leads

  E. Helmet

  F. Gloves

  G. Electrodes

  H. Safety goggles

  I. Chipping hammer

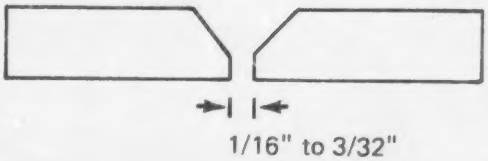
  J. Wire brush

II. Procedure

  A. Prepare metal to be welded (Figure 1)

  (NOTE: If metal thickness is over 1/8", then the edges should be beveled.)

FIGURE 1



Bevel Edges

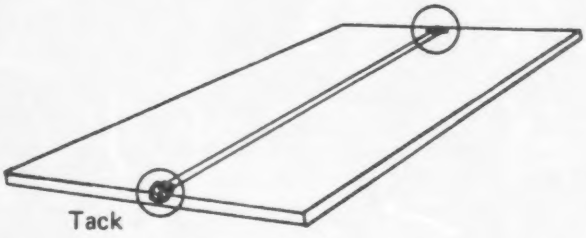
  B. Place two pieces of metal parallel to each other

  (NOTE: Leave a space from 1/16" to 3/32" between them.)

JOB SHEET #3

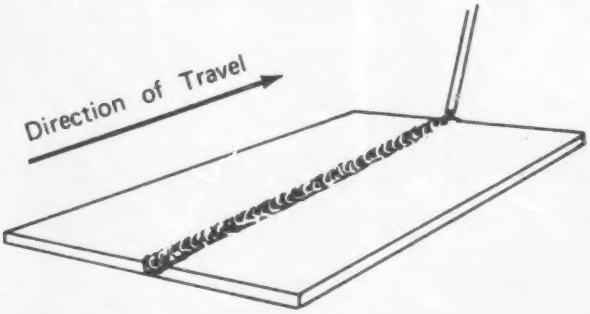
C. Tack weld pieces together at both ends (Figure 2)

FIGURE 2



D. Complete weld using a single pass (Figure 3)

FIGURE 3


Direction of Travel

E. Chip slag and brush weld

ARC WELDING
UNIT X

TEST

1. Match terms on the right to the correct definition.

_____a. Metal to be welded

_____b. Weld between two metal parts on the same plane

_____c. Joining of two or more pieces of metal together by the fusion process

_____d. Flow of current across a narrow gap

_____e. Made by one pass of the electrode

_____f. Type of edge preparation

_____g. Depression at the end of the weld

_____h. Metal rod which conducts a current from the electrode holder to the base metal

_____i. American Welding Society

1. Arc
2. Base metal
3. Bead weld
4. Bevel
5. Butt joint
6. Crater
7. Electrode
8. Welding
9. A.W.S.

2. List five safety precautions used in arc welding.

a.

b.

c.

d.

e.

3. List two kinds of arc welders.

a.

b.

4. Select from the following list common equipment used in arc welding by placing an "X" in the blank.

______a. Welder

______b. Torch

______c. Table

______d. Shield or helmet

______e. Gloves

______f. Ground clamp with lead

______g. Tape

______h. Wire brush

______i. Electrode

______j. Base metal

5. List four types of electrodes.

a.

b.

c.

d.

6. Place an "X" by the two most common sizes of electrode used in agricultural mechanics program.

______a. 1/4"

______b. 1/8"

______c. 1/16"

d. 5/32"

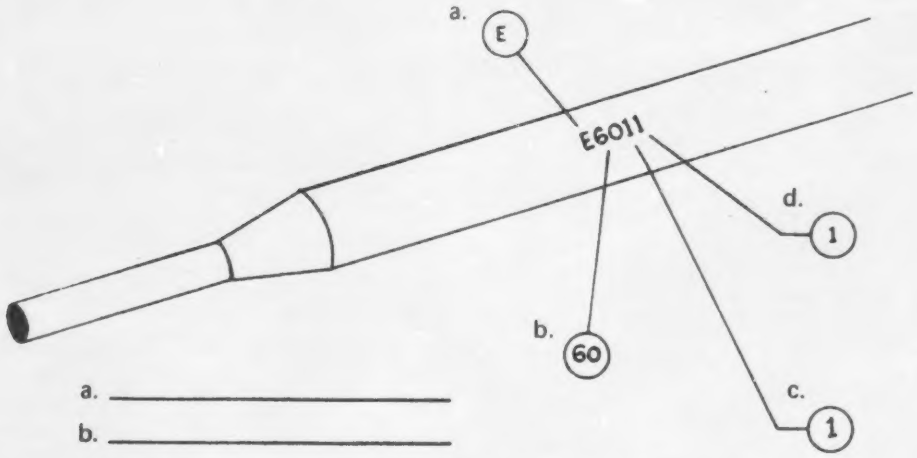
e. 3/8"

f. 3/32"

______g. 3/16"

______h. 3/64"

7. Identify the meaning of the numbers in the electrode classification system from the drawing.



a. ______________________

b. ______________________

c. ______________________

d. ______________________

8. Name two methods of coating electrodes.

a.

b.

9. List three purposes of electrode coating.

a.

b.

c.

10. Describe the effect of raising and lowering the arc welding current.

11. Name two methods of establishing an arc.

a.

b.

12. Select from the list below characteristics of the proper arc length by placing an "X" in the blank by the proper statements.

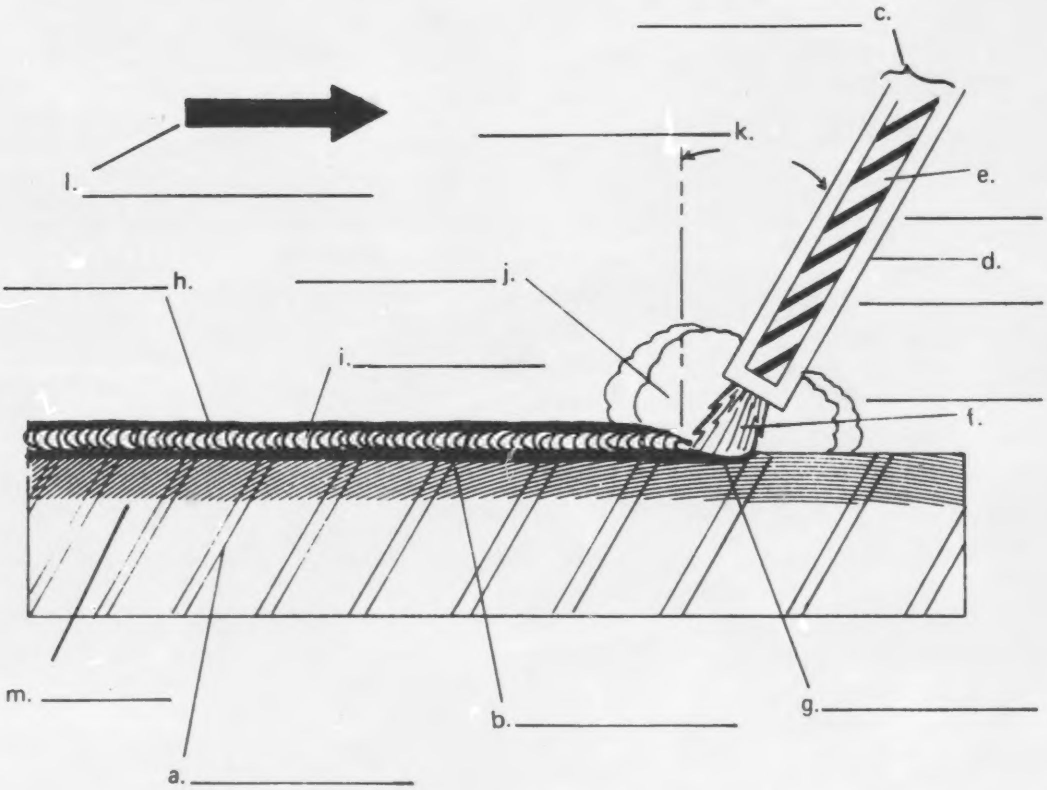
______a. Arc length is always 1/2" long

______b. Arc length is the same as the length of the electrode

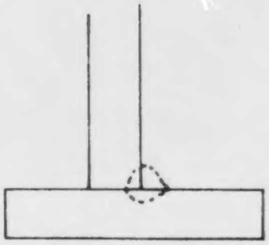
______c. End of electrode is the same distance from the base metal as the diameter of the electrode

______d. Correct arc length makes a steady hum of the welder and a "frying" sound at the arc

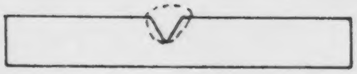
13. Label the parts of the drawing associated with the welding process.



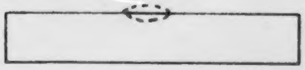
14. Identify the following welds.



a. ______________________

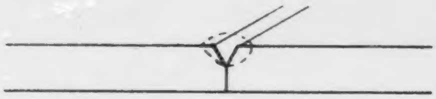


b. ______________________

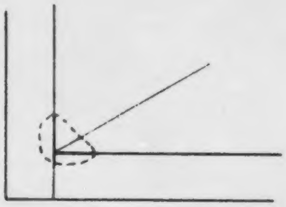


c. ______________________

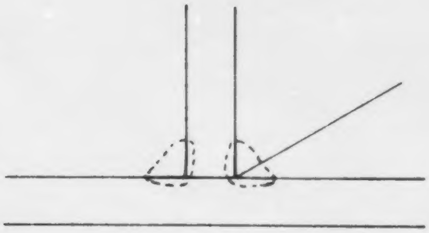
15. Identify five types of weld joints.



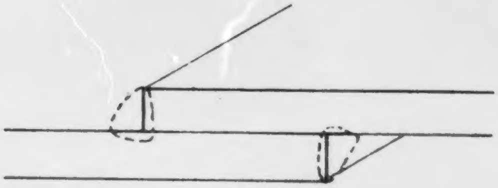
a. ______________________



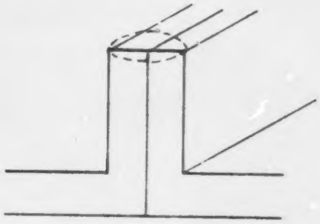
b. ______________________



c. ______________________



d. ______________________



e. ______________________

16. List four welding positions.

    a.

    b.

    c.

    d.

17. List four reasons for poor welds.

    a.

    b.

    c.

    d.

18. Demonstrate the ability to:

    a. Start, stop, and restart a bead.

    b. Construct a pad weld.

    c. Construct a butt weld.

    (NOTE: If these have not been completed before the test, ask the instructor when the above activities should be completed.)

ARC WELDING
UNIT X

ANSWERS TO TEST

1. a. 2
   b. 5
   c. 8
   d. 1
   e. 3
   f. 4
   g. 6
   h. 7
   i. 9

2. Any five of the following
   a. Never look at arc with the naked eye
   b. Use a head or face shield that is in good condition
   c. Wear suitable clothing to protect all parts of the body
   d. Do not strike an arc or weld until you are sure those in the vicinity have protective equipment or will look in the other direction
   e. Do not weld around combustible or flammable materials
   f. Do not pick up hot metal
   g. Do not weld in confined places without ventilation
   h. Always open main switch or disconnect plug when checking over a welder
   i. Do not leave electrode holder on welding table or in contact with grounded metal surface
   j. Do not use worn or frayed cables
   k. Stand on dry footing when welding
   l. Keep area around welder clean

   m. Keep tools and metals in their proper locations

3. Any two of the following
   a. A.C.
   b. D.C.
   c. TIG
   d. MIG
4. a, d, e, f, h, i
5. a. Mild steel
   b. High carbon steel
   c. Hard surfacing
   d. Alloys--Special purpose
6. b, d
7. a. Arc welding electrode
   b. Tensile strength
   c. Welding position
   d. Special characteristics
8. Any two of the following
   a. Wrapping
   b. Dipping
   c. Extruding
9. Any three of the following
   a. Stabilizes arc
   b. Shields molten puddle from air
   c. Floats impurities out of puddle
   d. Forms slag and slows cooling
   e. Increases speed and improves quality of weld

10. Description should include:
    a. Raising current--Produces more heat
    b. Lowering current--Produces less heat
11. a. Scratching
    b. Tapping
12. c, d
13. a. Base metal
    b. Penetration
    c. Electrode
    d. Coating (flux)
    e. Wire core
    f. Arc
    g. Crater
    h. Slag
    i. Weld
    j. Gaseous shield
    k. 15° - 30°
    l. Direction of travel
    m. Heat lines
14. a. Fillet
    b. Groove
    c. Bead
15. a. Butt
    b. Corner
    c. T
    d. Lap
    e. Edge

16. a. Flat
    b. Vertical
    c. Overhead
    d. Horizontal

17. Any four of the following
    a. Machine adjustment too hot or too cool
    b. Electrode size too large or too small
    c. Improper movement of electrode
    d. Improper angle of holding electrode
    e. Improper base metal preparation
    f. Arc length too short or too long

18. Performance skills will be evaluated to the satisfaction of the instructor.

CONSTRUCTION OF CONCRETE FORMS & REINFORCING CONCRETE
UNIT XI

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe the characteristics of a good form. The student should be able to list materials used to make concrete forms. The student should be able to select reinforcing materials for a form concrete construction job. Also, the student should be able to determine the location for the reinforcing materials for the farm concrete construction job. This knowledge will be evidenced by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define two terms associated with concrete forms and reinforcing concrete.
2. State the purpose of concrete forms.
3. List three requirements of good concrete forms.
4. List four of the common materials used in constructing concrete forms.
5. Discuss how to brace forms.
6. Discuss when to remove forms.
7. State the purpose for concrete reinforcement.
8. List three materials used for reinforcing concrete.
9. State five rules for reinforcing concrete.

CONSTRUCTION OF CONCRETE FORMS & REINFORCING CONCRETE
UNIT XI

SUGGESTED ACTIVITIES

I. Instructor

  A. Provide students with objective sheet.

  B. Provide students with information sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheets.

  F. Additional exercise – build forms for a sidewalk.

  G. Give test.

II. Students

  A. Read objectives.

  B. Study information sheets.

  C. Participate in building forms for sidewalk if job is available.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheets

  C. Transparency masters

    1. TM 1 – Wooden Concrete Forms

    2. TM 2 – Reinforcement suggestions

  D. Test

  E. Answers to test

II. References:

A. *A Practical Course in Concrete*, Portland Cement Association, 33 West Grande Avenue, Chicago, Illinois.

B. Phipps, Loyd J., H. F. McColly, and L. L. Scranton, *Farm Mechanics Text and Handbook*, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1967.

CONSTRUCTION OF CONCRETE FORMS & REINFORCING CONCRETE
UNIT XI

INFORMATION SHEET

I. Terms and Definitions

A. Forms — the materials that are built into the desired shape to hold the concrete, when poured, in place.

B. Reinforcing materials — steel bars or mesh placed in concrete to increase its tensile strength.

II. Purpose of Forms

A. Forms hold the concrete in the shape desired until it sets or hardens enough to stand by itself.

(NOTE: Normally, the longer the forms stay on, the stronger the concrete. Forms should be kept in place at least 24 hours on all jobs.)

III. Requirements of Good Forms

A. Must be true to size and shape.

B. Should be rigidly braced to prevent bulging, sagging, and spreading.

C. Should be tight and free from openings to prevent leaking.

D. Should be easy to remove after concrete has set.

IV. Constructing Forms (Transparency 1)

A. To obtain a smooth finish, forms should be made of dressed, tongued, and grooved lumber. Plywood and other manufactured products may be used to obtain a smooth finish.

B. Strips of sheet metal should be used to round off sharp corners and angles to make a stronger and neater job.

C. Crude oil or crankcase oil, painted on the inside of the forms, will keep the concrete from sticking to them when they are removed.

D. Forms should have all pieces of concrete removed from them before using again.

V. Bracing Forms

A. In addition to joining the forms with nails and wood bracing at strategic points, wire ties through the forms should be tightened against wood spacers.

B. The wood spacers should be removed as the placing of the concrete progresses.

C. Wires must be cut to remove the forms and they may be cut flush with the concrete after the forms are removed.

INFORMATION SHEET

VI. Removing Forms

A. In warm weather, forms should remain in place two or three days.

B. In cold weather, allow twice as long.

C. In no case, should the forms be removed until the concrete has thoroughly set and there is no danger of damaging.

D. Forms left in place for at least a week aid in the curing process by protecting the concrete from drying too rapidly.

E. The weather, temperature, and nature of the work determine the length of time to leave the forms in place.

VII. Reinforcement is for the Purpose of Increasing the Strength of Concrete

VIII. Materials Used for Reinforcing Concrete

A. Steel rod and wire mesh are usually used for reinforcement.

B. For large jobs, engineers should be consulted for the proper type, size, and spacing of reinforcements.

IX. Rules for Reinforcing Concrete (Transparency 2)

A. Use only clean steel (free from rust, paint, and scale).

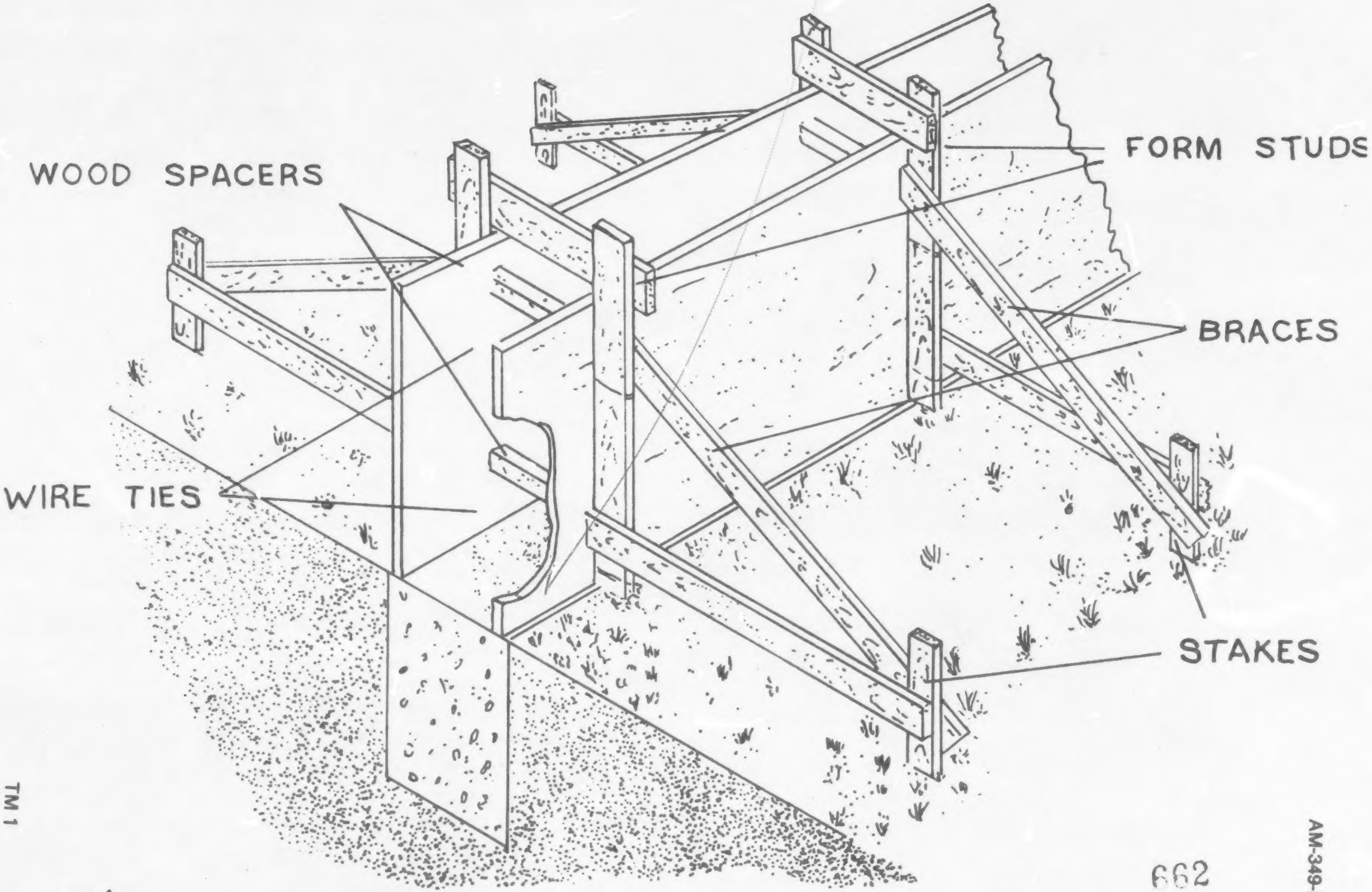
B. Place steel no closer than 3/4 inches from the outside surface.

C. Lap all bars 48 times their diameter (1/2 inch bars should be lapped 24 inches and then wired together).

D. Place reinforcement where concrete will be in tension (such as corners, joints, etc.)

E. Position wire mesh or steel near center of depth of slab or sidewalk.

WOODEN CONCRETE FORM


WOOD SPACERS
FORM STUDS
BRACES
WIRE TIES
STAKES

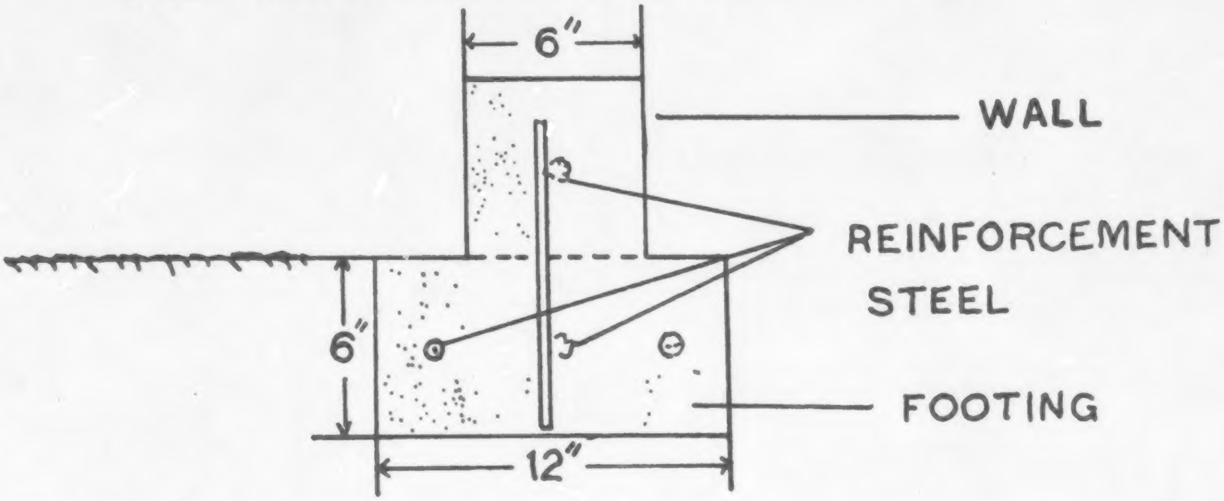
TM 1

661

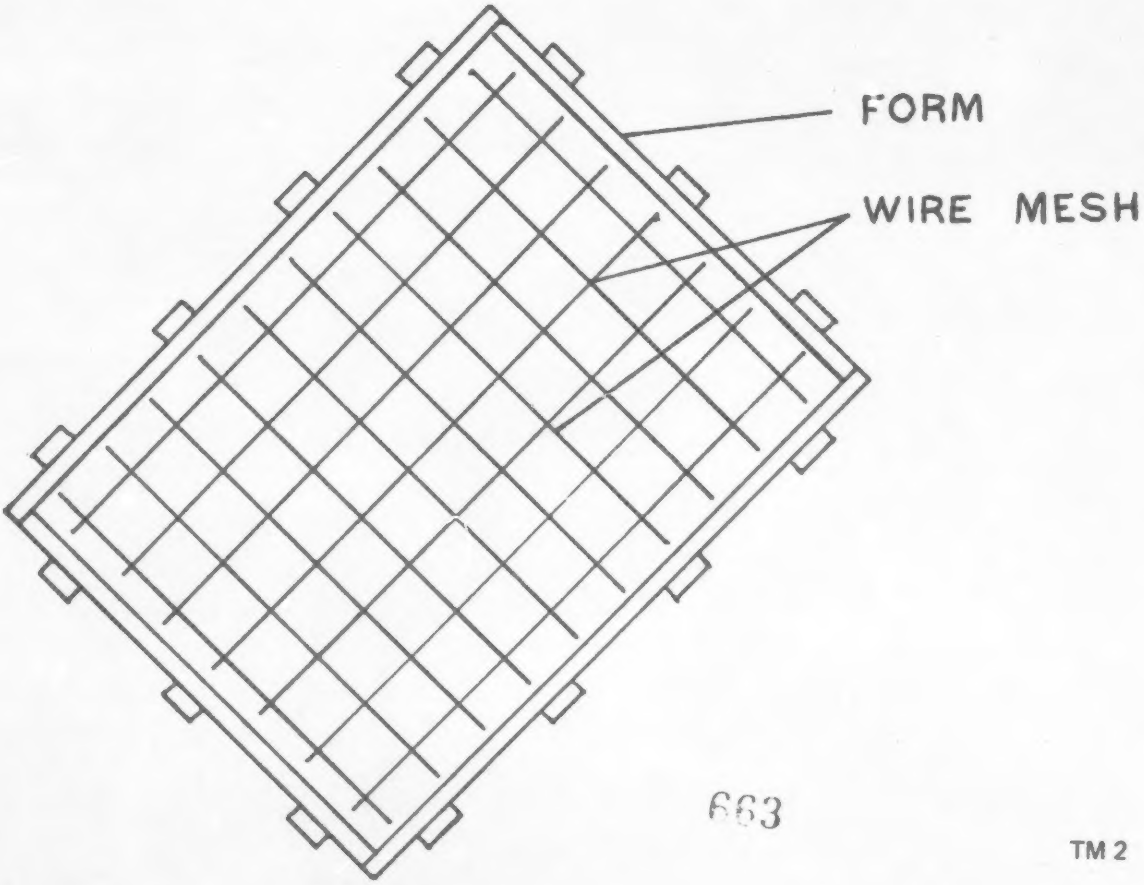
662

REINFORCEMENT

WALL AND FOOTING CROSS - SECTION


6"
WALL
REINFORCEMENT
STEEL
6"
FOOTING
12"

SLAB


FORM
WIRE MESH

CONSTRUCTION OF CONCRETE FORMS & REINFORCING CONCRETE
UNIT XI

TEST

1. Define two terms associated with concrete forms and reinforcing concrete.
   a. Forms
   b. Reinforcing materials
2. State the purposes of concrete forms.
3. List three requirements of good concrete forms.
   a.
   b.
   c.
4. List six of the common materials used in constructing concrete forms.
   a.
   b.
   c.
   d.
   e.
   f.
5. Discuss in detail how to brace forms.
6. Discuss when to remove forms.
7. State the purpose for concrete reinforcement.

TEST

8. List three materials used for reinforcing concrete.

   a.

   b.

   c.

9. State five rules for reinforcing concrete.

   a.

   b.

   c.

   d.

   e.

CONSTRUCTION OF CONCRETE FORMS & REINFORCING CONCRETE
UNIT XI

ANSWERS TO TEST

1. a. Forms – the materials that are built into the desired shape to hold the concrete, when poured, in place.

   b. Reinforcing materials – steel bars or mesh placed in concrete to increase its tensile strength.

2. Forms hold the concrete in the shape desired until it sets or hardens enough to stand by itself.

3. Any of the following:

   a. Must be true to size and shape.

   b. Should be rigidly braced to prevent bulging, sagging, and spreading.

   c. Should be tight and free from openings to prevent leaking.

   d. Should be easy to remove after concrete has set.

4. Any of the following:

   a. Smooth dressed, tongued, and grooved lumber.

   b. Plywood and other manufactured products with a smooth finish.

   c. Strips of sheet metal.

   d. Oil to seal forms.

   e. Dimension lumber for bracing.

   f. Nails and wire.

5. Discussion should include these points:

   a. Nails and wood bracing.

   b. Wire ties and wood spacers.

   c. Removal of wire ties and wood spacers.

6. Discussion should include these points:

   a. In warm weather, forms should remain in place two or three days.

   b. In cold weather, allow twice as long.

ANSWERS TO TEST

- c. In no case should the forms be removed until the concrete has thoroughly set and there is no danger of damaging.
- d. Forms left in place for at least a week aid the curing process by protecting the concrete from drying too rapidly.
- e. The weather, temperature, and nature of the work determine the length of time to leave forms in place.

7. Reinforcement is for the purpose of increasing the strength of concrete.

8. Any of the following:
   - a. Steel rod
   - b. Wire mesh
   - c. Larger sizes of the above

9. Any of the following:
   - a. Use only clean steel (free from rust, paint, and scale).
   - b. Place steel no closer than 3/4 inches from the outside surface.
   - c. Lap all bars 48 times their diameter (1/2 inch bars should be lapped 24 inches and then wired together).
   - d. Place reinforcement where concrete will be in tension (such as corners, joints, etc.).
   - e. Position wire mesh or steel near center of depth of slab or sidewalk.

MATERIALS FOR QUALITY CONCRETE
UNIT XII

UNIT OBJECTIVE

After completion of the unit, the student should be able to describe portland cement characteristics and types, and select materials for quality concrete. The student should be able to determine amounts of material to use and proper mixing. This knowledge will be evidenced by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After the completion of this unit, the student should be able to:

1. Match terms associated with concrete when definitions are given.
2. List six uses of concrete in agriculture.
3. List five advantages of concrete construction.
4. Match portland cement types with characteristics of each.
5. List the ingredients used in concrete.
6. Write the approximate volume of cement, water, and aggregate in concrete.
7. Describe the makeup of a 1:2:3 concrete mixture.
8. Identify from a list the primary factor in concrete strength.
9. Demonstrate the ability to complete a table on determining the moisture in sand.
10. Describe how consistency of concrete should be altered.
11. State Fullers rule as it applies to concrete.
12. List in order the steps in machine and hand mixing.
13. List three advantages and three disadvantages of ready-mixed concrete.
14. Describe how to properly prepare for and order ready-mix.
15. Demonstrate the ability to determine the amount of ready-mixed concrete needed for a given job.

MATERIALS FOR QUALITY CONCRETE
UNIT XII

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Give test.

  G. Tour ready-mix plant, mix concrete if time allows.

II. Student:

  A. Read objectives.

  B. Study information sheet.

  C. Complete the assignment sheets.

  D. Take test.

  E. Tour plant and mix concrete if time allows.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

TM 1 - Volume of Materials in Concrete Moisture in Sand
TM 2 - Recommended Mixtures, Fullers Rule
TM 3 - Recommended Mixtures
TM 4 - H_2O - Cement Ratio

INSTRUCTIONAL MATERIALS

D. Assignment sheets

   1. Applying Fullers rule

   2. Determining cubic yards

E. Answers to Assignment Sheet No. 1

   Answers to Assignment Sheet No. 2

F. Test

G. Answers to test

II. References:

A. *Concrete: Suggested Lesson Plans for Teachers of Vocational Agriculture*, Ag Ed Department, Texas A&M University, College Station, Texas.

B. *Ready-Mix Concrete for the Farm*, Portland Cement Association, 33 West Grand Avenue, Chicago, Illinois.

C. *A Practical Course in Concrete*, Henry Giese, Portland Cement Association, 33 West Grande Avenue, Chicago, Illinois.

MATERIALS FOR QUALITY CONCRETE
UNIT XII

INFORMATION SHEET

I. Terms and definitions

  A. Concrete — a mixture of a paste of portland cement and water, binding fine and coarse aggregates, into a rock-like mass as the paste hardens through chemical reaction.

  B. Cement — manufactured product of lime, iron oxide, silica and alumina.

  C. Sand — (fine aggregate) particles that range from very fine to ¼ inch in diameter.

  D. Gravel — (coarse aggregate) particles range from ¼ to 1½ inches.

  E. Fullers rule — states that the mixing of a total of 42 volumes of cement, sand, and gravel will produce 27 volumes of concrete.

  F. Water-cement ratio — the ratio of water to cement usually expressed in gallons per bag of cement.

II. Some Agricultural uses of concrete

  A. Fence posts

  B. Water troughs

  C. Walks

  D. Driveways

  E. Floors

  F. Feeding troughs

  G. Walls and foundations

  H. Septic tanks

  I. Culverts

  J. Feeding floors

  K. Manure pits

  L. Silos

  M. Steps

INFORMATION SHEET

N. Setting posts

O. Cattle guards

III. Advantages of concrete

A. Fire proof

B. Durable and permanent

C. Water tight

D. Economical

E. Termite and rodent proof

F. Low maintenance

G. Storm resistant

H. Readily adapted

IV. Types and uses of Portland cement

A. Type I — normal portland; sidewalks, floors, and bridges.

B. Type II — modified portland; lower heat of hydration; heavy, thick work.

C. Type III — high, early, strength; used when high strengths are desired at very early periods (1-3 days); using during low temperatures.

D. Type IV — low heat; used only in large masses; dams, etc.

E. Type V — sulfate resistant; resists severe sulfate and alkali action.

V. Ingredients used in concrete

A. Cement

B. Sand (fine aggregate)

C. Gravel (coarse aggregate)

D. Water — should be of drinking water quality, free of oil and impurities.

(NOTE: sand and gravel are filler material to make concrete economical. They should be hard, rounded and clean.)

INFORMATION SHEET

   E. Wet sand — (½ gallon water per cubic foot) ball of sand holds its shape when hand is opened.

   F. Very wet sand — (¾ gallon water per cubic foot) ball formed, leaves hand wet.

VI. Proportion of materials in concrete (Transparency 1)

   A. Approximate volume of materials in concrete

      1. Cement - 10%

      2. Water - 15%

      3. Sand and gravel - 75%

VII. Composition of a 1:2:3 Concrete Mixture

   A. First digit equals pa[illegible]ement

   B. Second digit equals parts of sand

   C. Third digit equals parts of gravel

VIII. Factors determining concrete strength (Transparency 4)

   A. Primarily determined by the amount of water added for each sack of cement (water-cement ratio)

      (NOTE: The proper amounts of water and cement should be established first and not altered. Aggregates should be altered to get a workable mixture.)

   B. The amount of water in the sand must be considered when measuring the amount of water in the mixture (example: a five-gallon mix should contain only five gallons water *including the water in the sand.*)

      (NOTE: Recommended mixtures

      1. 5 gallon mix — for acid or alkaline resistant work or thin work

      2. 6 gallon mix — water tight and reinforced concrete

      3. 7 gallon mix — foundation walls and retaining walls

IX. Measuring Moisture in Sand (Transparency 2)

   A. Hard press method (press sample into a ball)

   B. Damp sand (¼ gallon water per cubic foot; ball of sand falls apart when hand is opened)

INFORMATION SHEET

   C. Wet sand (½ gallon of water per cubic foot; ball holds shape when hand is opened)

   D. Very wet sand (¾ gallon of water per cubic foot; ball sparkles, hand is wet)

X. Consistency of mixture

   A. Controlled by addition or subtraction of aggregate

   B. Consistency established by trial batches

XI. Determining amount of materials needed in concrete (Transparency 3)

   A. Volume of raw material does not equal finished volume (the smaller particles fill in spaces between larger particles).

   B. Fuller rule – mixing of a total of 42 volumes of cement, sand, and gravel produces 27 volumes of concrete.

XII. Mixing concrete

   A. Machine mixing

      1. Determine mixer capacity.

      2. Establish water cement ratio for job (correct for sand moisture).

      3. Place measured amount of water in mixer.

      4. Add part of gravel.

      5. Add measured amount of cement.

      6. Add sand and gravel to obtain proper consistency.

      7. Mix for 2-3 minutes.

   B. Hand mixing

      1. Establish water-cement ratio.

      2. Place sand in mixing container.

      3. Add cement and mix well with sand.

      4. Add gravel and mix.

      5. Add water and mix.

      6. Add sand and/or gravel for proper consistency.

INFORMATION SHEET

XIII. Ready-mixed concrete

- A. Advantages
    - 1. Convenient
    - 2. Less hired labor needed
    - 3. Quicker
    - 4. In some cases more economical
    - 5. Assured of good quality
- B. Disadvantages
    - 1. Cost may by high (mileage)
    - 2. Forms must be stronger
    - 3. Not always available when wanted
    - 4. Sometimes large areas ready to finish at same time

XIV. Preparing and ordering Ready-mix

- A. Ordering ready-mix
    - 1. Determine water-cement ratio required for job.
    - 2. Determine bags of cement per cubic yard of concrete (range: from 5-7 bags).
    - 3. Determine amount of concrete needed.
    - 4. Determine type of mix (1-2-3)
    - 5. Call early and give (A-D) information and:
        - a. Time you want delivery.
        - b. Specific directions to job site.
    - 6. Reconfirm your order early on day of delivery.
- B. Prepare site:
    - 1. Wet forms and subgrade 4-6 hours ahead of pouring concrete (keeps water in concrete).

INFORMATION SHEET

2. Have forms well braced.

3. Have equipment ready.

XV. Determining the amount of concrete needed

A. Determine the surface area (length x width)

B. Determine average depth of concrete

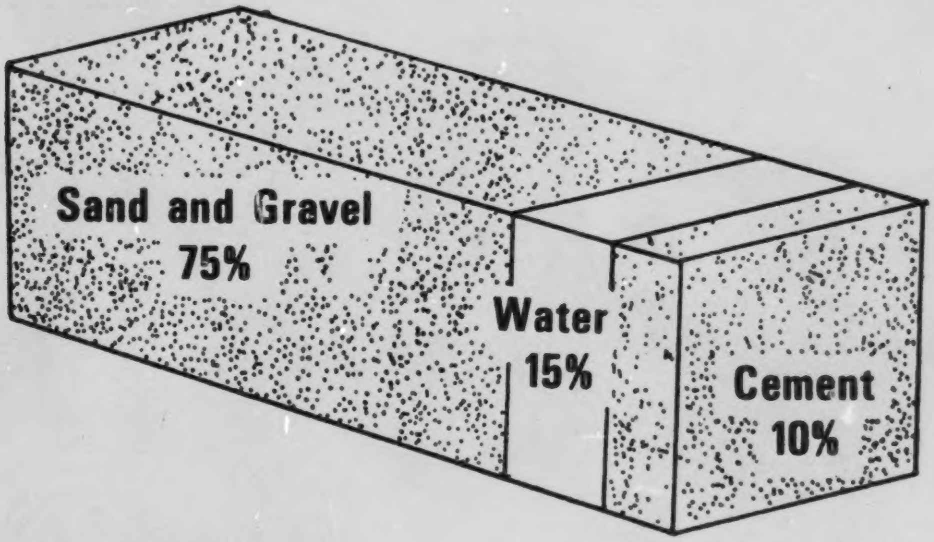
C. Determine cubic feet

$$\frac{\text{(Length in feet x width in feet x thickness in inch)}}{12}$$

D. Determine cubic yards

$$\text{(27 cubic feet in 1 cubic yard)} = \frac{\text{cubic feet}}{27}$$

VOLUME of MATERIALS in CONCRETE


Sand and Gravel
75%
Water
15%
Cement
10%

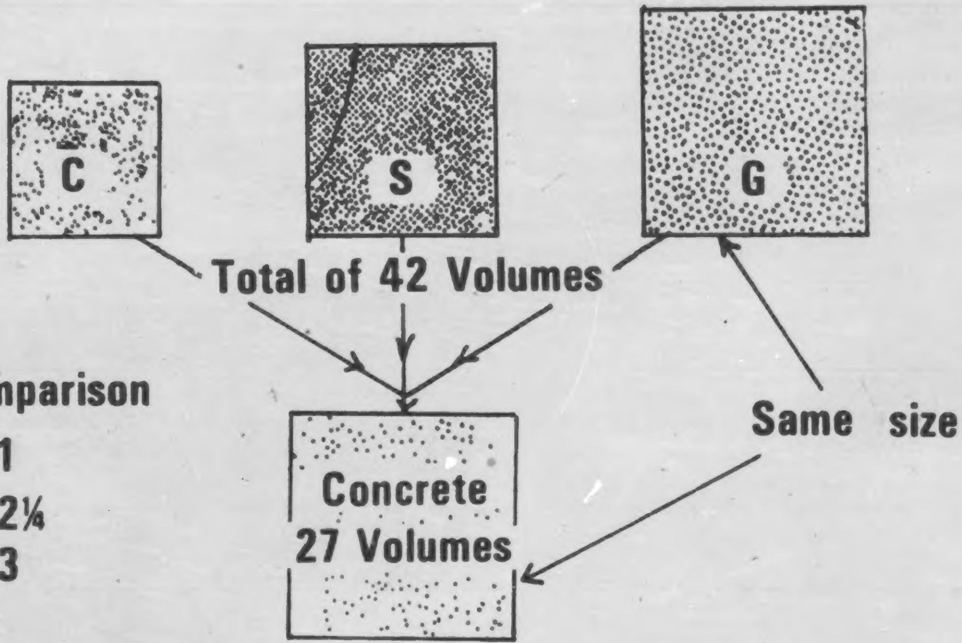
MOISTURE in SAND

Damp Sand	Falls apart	¼ gal. per cu. ft.
Wet Sand	Ball holds shape	½ gal. per cu. ft.
Very Wet Sand	Sparkles, wets hand	¾ gal. per cu. ft.

RECOMMENDED MIXTURES

Mix	Water (gal.) / Sack Cement			Trial Batch	
	Sand			cu. ft. Sand	cu. ft. Gravel
	Damp	Wet	Very Wet		
5 gal.	4½	4	3¾	1¾	2
6 gal.	5½	4½	4	2¼	3
7 gal.	6¼	5½	4¾	2¾	4

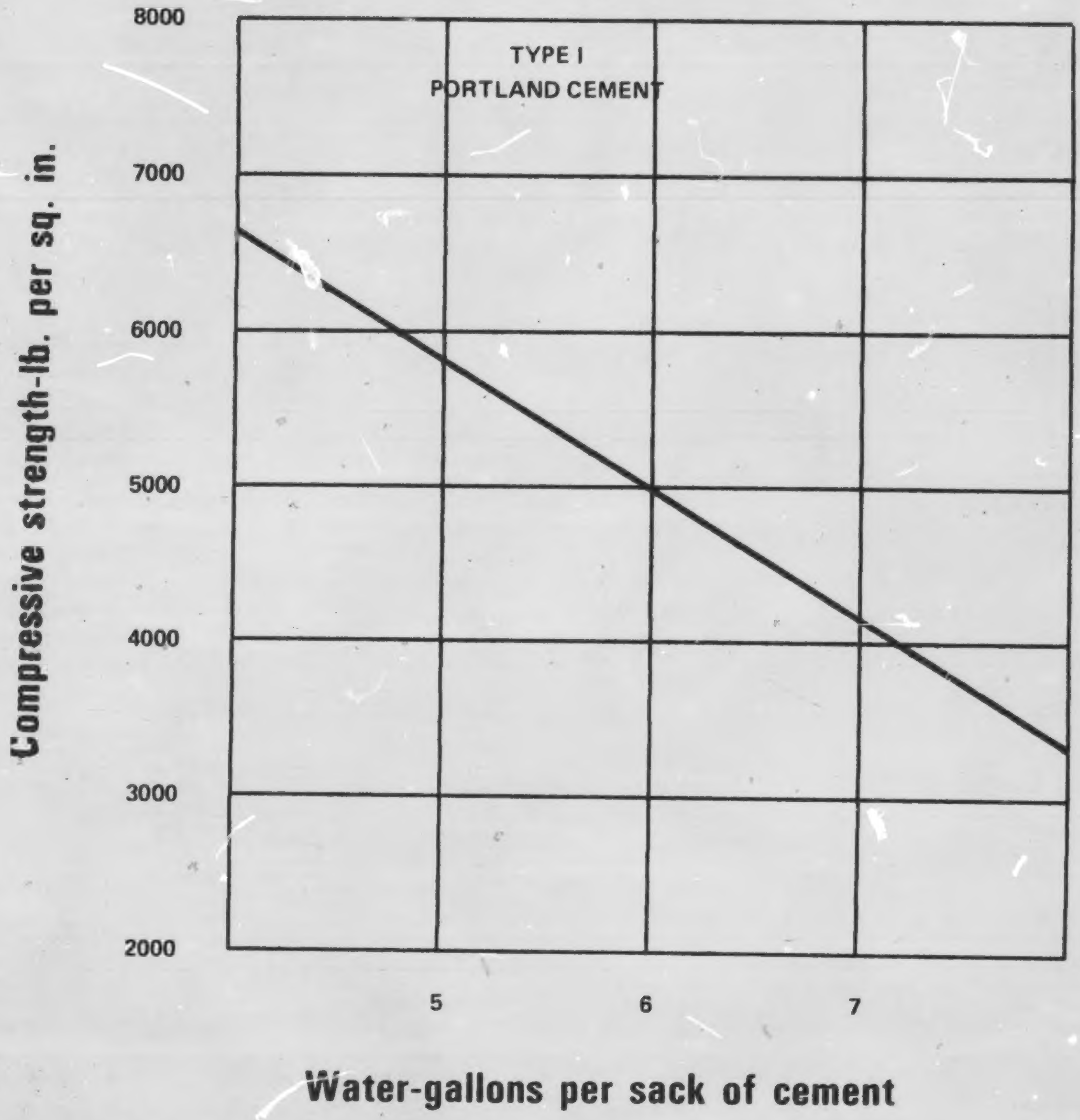
FULLER'S RULE


C
S
G
Total of 42 Volumes
Same size
Concrete
27 Volumes

Size Comparison

C=1
S=2¼
G=3

HOW WATER-CEMENT RATIO AFFECTS STRENGTH



MATERIALS FOR QUALITY CONCRETE
UNIT XII

ASSIGNMENT SHEET NO. 1--APPLYING FULLERS RULE

Using a 6 gallon mix (1-2¾-3), how many sacks of cement and cubic yards of sand and gravel will be needed to build a sidewalk 4" thick, 6 feet wide, and 100 feet long?

1. a. Determind cubic feet of concrete

$\frac{\text{Length x width x depth}}{12}$ ____________________ cubic feet

b. Determine cubic feet of raw materials

$\frac{\text{Cubic feet concrete x 42}}{27}$ ____________________ cubic feet

c. Determine total volumes of mix

1 + 2¾ + 3 = ____________________

d. Determine sacks of cement

$\frac{\text{Cubic feet of raw materials}}{\text{Total volumes of mix}}$ = ____________________ sacks

e. Determine the cubic yards of sand

$\frac{\text{Sacks of cement* x sand proportion of mix (2.25)}}{27}$

*(sack contains 1 cubic foot)

____________________ cubic yards

f. Determine the cubic yards of gravel

$\frac{\text{Sacks of cement x gravel proportion (3)}}{27}$ =

____________________ cubic yards

MATERIALS FOR QUALITY CONCRETE
UNIT XII

ASSIGNMENT SHEET NO 2--DETERMINING CUBIC FEET OF CONCRETE FOR A SLAB 200x20x4" DEEP

1. a. Determine surface area - length ____________________, width ______

   b. Determine average depth ____________________

   c. Determine cubic feet

   $$\frac{\text{Length x width x thickness}}{12} = \_\_\_\_\_\_\_\_\_\_\_\_$$

   d. Determine cubic yards

   $$\frac{\text{Cubic feet}}{27} = \_\_\_\_\_\_\_\_\_\_\_\_$$

   (NOTE: 27 cubic feet = 1 cubic yard)

MATERIALS FOR QUALITY CONCRETE
UNIT XII

ANSWERS TO ASSIGNMENT SHEETS

A. Assignment Sheet No. 1

1. a. $\frac{100\times6\times4}{12}$ = 200 cubic feet of concrete

   b. $\frac{200\times42}{27}$ = 311 cubic feet of raw materials

   c. $1+2\frac{1}{4}+3$ = $6\frac{1}{4}$ parts

   d. $\frac{311}{6.25}$ = 49.9 or 50 sacks

   e. $\frac{50\times2.25}{27} = \frac{112.5}{27}$ = 4.17 cubic yards

   f. $\frac{50\times3.0}{27} = \frac{150}{27}$ = 5.56 cubic yards

B. Assignment Sheet No. 2

1. a. Length 200′ Width 20′

   b. Depth 4″

   c. $\frac{200\times20\times4''}{12}$ = 1,333.33 cubic feet

   d. $\frac{1,333.34}{27}$ = 49.38 cubic yards or 49½ yards

MATERIALS FOR QUALITY CONCRETE
UNIT XII

TEST

1. Match the following concrete terms with the definition.

    _____ a. Concrete
    _____ b. Cement
    _____ c. Sand
    _____ d. Gravel
    _____ e. Fullers Rule
    _____ f. Water-Cement Ratio

    1. Ratio of water to cement.
    2. Manufactured product of lime, iron, oxide, silica, and alumina.
    3. Aggregates ranging from ¼" to 1¾" in size.
    4. Aggregates ranging from very fine to ¼" in diameter.
    5. Mixing a total of 42 volumes of cement, sand and gravel will produce 27 volumes of concrete.
    6. Mixture of a paste of cement and water, binding fine and coarse aggregate into a rock-like mass.

2. List six uses of concrete in agriculture.

    a.
    b.
    c.
    d.
    e.
    f.

3. List five advantages of concrete construction.

    a.
    b.
    c.
    d.
    e.

TEST

4. Match the portland cement types with the correct characteristic.

___ a. Type I Portland

___ b. Type II Portland

___ c. Type III Portland

___ d. Type IV Portland

___ e. Type V Portland

1. Normal portland

2. Modified portland--lower hydration heat

3. Sulfate resistant type

4. Used in massive structures, dams, etc.

5. High early strength type

5. List the four ingredients of concrete.

a.

b.

c.

d.

6. Write the approximate volume each of the following constitute of a concrete batch.

Cement __________ %

Water __________ %

Sand and Gravel __________ %

7. Describe (by volume) what a 1:2:3 mixture would be.

1.

2.

3.

8. Identify from the following list what primarily determines the strength of concrete by circling appropriate letter.

a. Water cement ratio.

b. Breaking strength of aggregate.

c. Amount of rock added.

TEST

9. Complete the following table on moisture in sand.

a. ____ sand--ball holds shape ½ gallon per cubic ft.

b. ____ sand--ball falls apart ¼ gallon per cubic ft.

c. ____ sand--sparkles, wets hand ¾ gallon per cubic ft.

(1) Wet (2) Damp (3) Very wet

10. Describe how the consistency of concrete should be altered.

11. State Fullers rule as it applies to concrete.

12. Place in order the steps of hand mixing and machine mixing. (Place 1 for first, 2 for second, etc.)

Hand Mixing

____ a. Add gravel and mix.

____ b. Add cement and mix with sand.

____ c. Establish water-cement ratio.

____ d. Place sand in mixing container.

____ e. Add water and mix.

____ f. Add sand and gravel for proper consistency.

Machine Mixing

____ a. Add sand and gravel for consistency.

____ b. Determine mixer capacity.

____ c. Mix 2-3 minutes.

____ d. Add part of gravel.

____ e. Establish water-cement ratio.

____ f. Place measured amount of water in mixer.

____ g. Add measured amount of cement.

13. List three advantages and three disadvantages of ready-mix concrete.

Advantages

1.

2.

3.

Disadvantages

1.

2.

3.

TEST

14. Describe how to prepare for, and order ready mix concrete.

Preparing for	Ordering
1.	1.
2.	2.
3.	3.
	4.
	5.
	6.

15. Determine the amount, in cubic yards, of ready mix concrete required for a sidewalk 4 inches thick, 6 feet wide, and 200 feet long.

MATERIALS FOR QUALITY CONCRETE
UNIT XII

ANSWERS TO TEST

1. 6 a.
   2 b.
   4 c.
   3 d.
   5 e.
   1 f.

2. Any six of the following:

   Fence posts
   Water troughs
   Walks
   Drive-ways
   Floors
   Feeding troughs
   Walls and foundations
   Septic tanks
   Feeding floors
   Culverts
   Manure pits
   Silos
   Steps
   Setting posts
   Cattle guards

3. Any five of the following:

   Fireproof
   Durable and permanent
   Water tight
   Economical
   Termite and rodent proof
   Low maintenance
   Storm resistant
   Readily adapted

4. 1. a.
   2 b.
   5 c.
   4 d.
   3 e.

ANSWERS TO TEST

5. a. Cement

   b. Sand (fine aggregate)

   c. Gravel (coarse aggregate)

   d. Water

6. Cement - 10%

   Water - 15%

   Sand and gravel - 75%

7. 1. Parts of cement

   2. Parts of sand

   3. Parts of gravel

8. a. Water-cement ratio

9. a. 1

   b. 2

   c. 3

10. Controlled by addition or subtraction of aggregate.

11. Mixing a total of 42 volumes of cement, sand, and gravel produces 27 volumes of concrete.

12. 4 a.

    3 b.

    1 c.

    2 d.

    5 e.

    6 f.

    6 a.

    1 b.

    7 c.

    4 d.

    2 e.

    3 f.

    5 g.

ANSWERS TO TEST

13.

Advantages (any three)	Disadvantages (any three)
Convenient	Cost may be high
Less hired labor	Forms must be strong
Quicker	Not always available
Assured of good quality	Sometimes large areas ready to finish at same time
May be more economical	

14. Ready-mix (ordering)

1. Establish water-cement ratio for job.
2. Establish bags of cement per yard of cement.
3. Determine amount of concrete needed.
4. Determine type of mix.
5. Call early and list (1-4), time of delivery, and directions to job site.
6. Reconfirm order on day of delivery.

Ready-mix (preparing for)

1. Wet forms and subgrade 4-6 hours before pouring concrete.
2. Have forms well braced.
3. Have equipment ready.

15. $\frac{200 \times 6 \times 4}{12} = \frac{4800}{12} = 400$

$\frac{400}{27} =$ 14.81 cubic yards of ready mix

PLACING, FINISHING AND CURING CONCRETE
UNIT XIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to match a list of terms with the definitions dealing with placing, finishing and curing concrete. The student should be able to name the procedures involved in placing concrete. The student should be able to list the steps used in finishing concrete. The student should be able to describe the various types of finishes, their uses and how they are obtained. Also, the student should be able to name the processes used in properly curing concrete. This knowledge will be evidenced by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms dealing with placing, finishing and curing concrete with the proper definition.
2. Name five procedures used in properly placing concrete.
3. Name five procedures that are used in finishing concrete.
4. Match the various types of concrete finishes to their uses, and how they are obtained.
5. List two factors to consider in curing concrete.
6. List the three factors which proper concrete curing improves.
7. List two common methods of curing concrete.

PLACING, FINISHING AND CURING CONCRETE
UNIT XIII

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheets.

   B. Provide each student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Give test.

II. Students:

   A. Read objectives.

   B. Study information sheets.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheets

   C. Transparency masters

      TM 1 - Screeding and metal trowel

      TM 2 - Edging and jointing

      TM 3 - Types of finish

      TM 4 - Curing requirements

      TM 5 - Effects of curing

   D. Test

   E. Answers to test

II. References:

A. *Agricultural Education Teaching Materials Center*, Texas A&M College Station, Texas VC3, Basic Voc AGII.

B. *A Practical Course in Concrete*, Henry Glare, Portland Cement Association, 33 West Grande Avenue, Chicago, Illinois.

PLACING, FINISHING AND CURING CONCRETE
UNIT XIII

INFORMATION SHEET

I. Terms and definitions

   A. Screeding – removing the excessive concrete from the form.

   B. Edging – rounding the edges to prevent chipping or damage to the edge of the concrete.

   C. Floating – pushing the larger aggregates down away from the surface and bringing mortar to the surface.

   D. Curing – plenty of moisture is present to obtain maximum hydration of the cement.

   E. Scaling – when surface breaks away from the slab.

   F. Crazing – fine hair cracks on surface of concrete.

   G. Dusting – powdery material on surface of concrete.

   H. Jointer – to create a groove across concrete to control cracking.

II. Placing Procedures

   A. Place concrete in forms as soon as possible after mixing. It will begin to set within 30 to 40 minutes.

   B. Place concrete where it is needed. Do not drag or allow it to flow.

   C. Place in even layers about 6 to 8 inches deep and tamp well.

   D. In slab construction, start at the point farthest away from you, so the next batch will be placed against it to prevent segregation.

   E. Avoid dumping concrete against side of forms.

   F. Avoid letting the chute or buggy hit the side of the forms.

   G. Tamp and spade the concrete mixture thoroughly to prevent air pockets.

   H. Work the mixture against the side of the forms so the large aggregates will be forced away from the forms for a smooth surface.

   I. In all cases, procedures should be carried out to prevent water from collecting at the ends and corners of the forms.

INFORMATION SHEET

III. Finishing Concrete (TM-1 and TM-2)

A. Concrete should be screeded as soon as it has been tamped or spaded in the forms.

B. Finishing should be delayed until the surface is quite stiff but still workable.

C. Surface water should be allowed to evaporate.

D. Dry cement should not be sprinkled on top to remove moisture for finishing purposes, as this material will form a layer that is likely to develop hair line cracks.

E. After the concrete is edged and jointed, it should be floated.

F. Trowel the concrete to bring a thick film of cement to the top, which results in a smooth level finish.

IV. Types of Concrete Finishes (TM-3)

	Type	Use	Obtained By
A.	Gritty, non-slipping	Walks, dairy barn floors	Using wood float
B.	Coarse, scored surface	Driveways, lots, ramps, floors	Using a stiff broom
C.	Smooth, troweled finish	Table tops, feed troughs	Using steel trowel
D.	Pea grain	Porches and patios	Washing with water hose

V. Curing Concrete (TM-4 and TM-5)

A. Curing should be started as early as possible and continued for at least seven days.

B. Moisture curing greatly increases the strength of the concrete.

VI. Factors Improved by Proper Concrete Curing

A. Strength

B. Durability

C. Watertightness

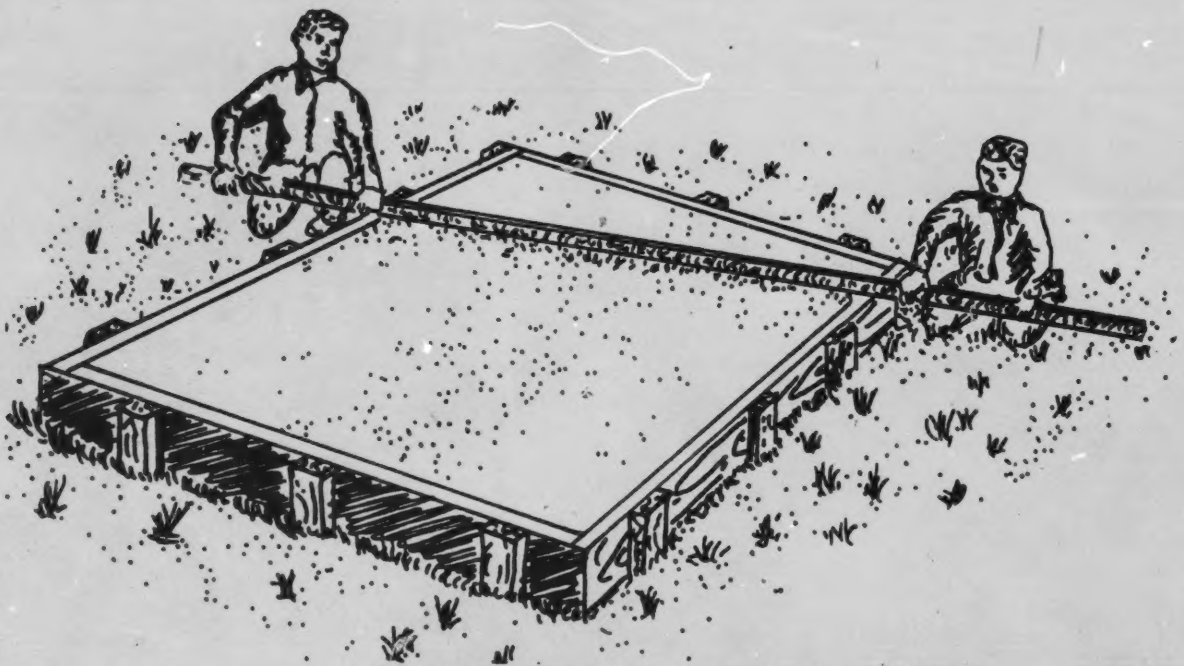
INFORMATION SHEET

VII. The Common Methods of Curing Concrete

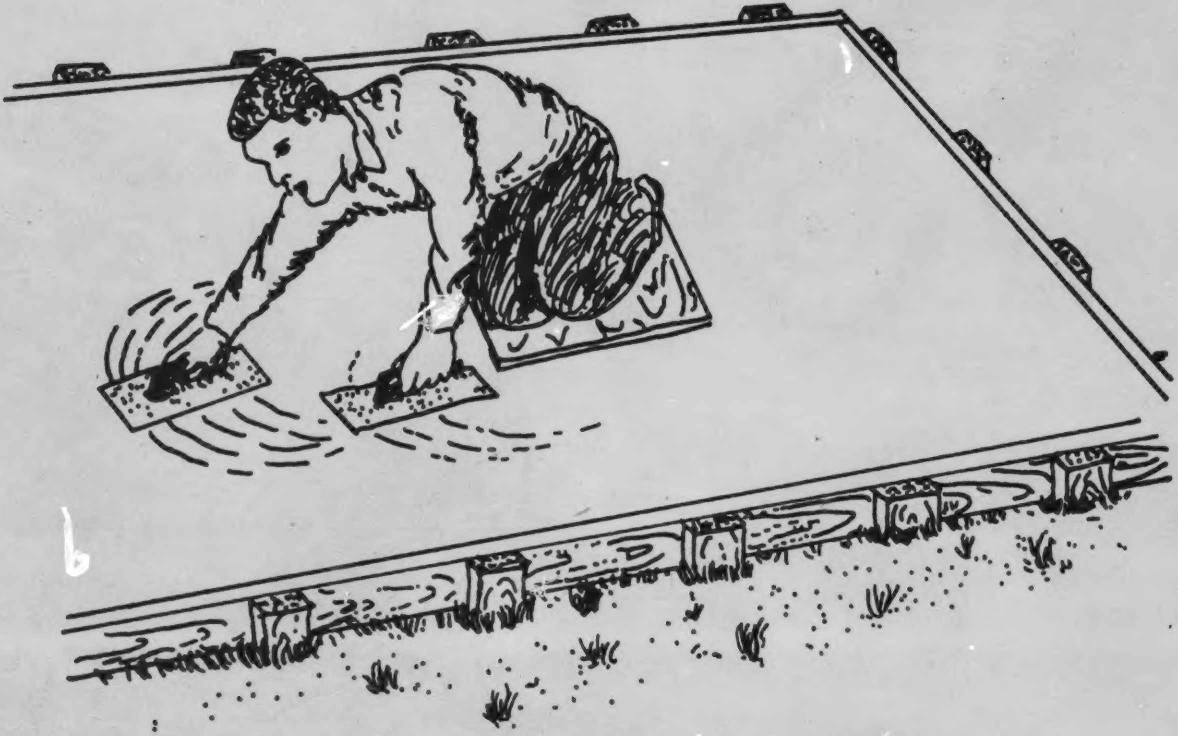
A. Cover with straw, sand, wet burlap, or canvas as soon as possible without marring surface. Keep this covering constantly wet during the curing process.

B. Flood the surface and hold the water on the surface with some type of border around the edge of slab.

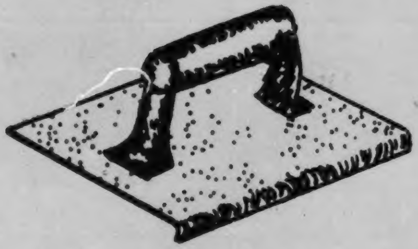
SCREEDING



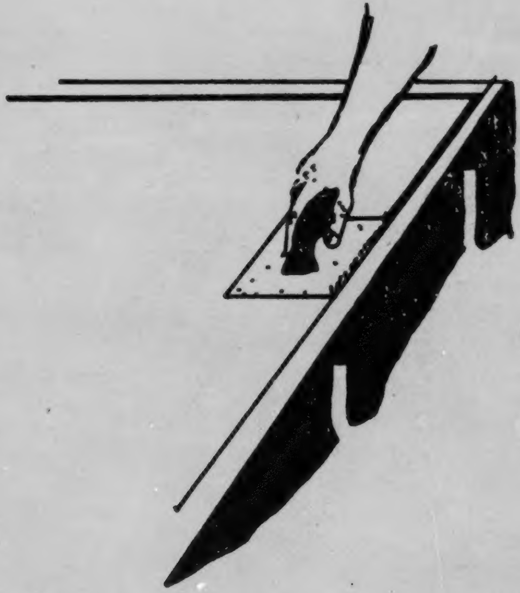
METAL TROUGH

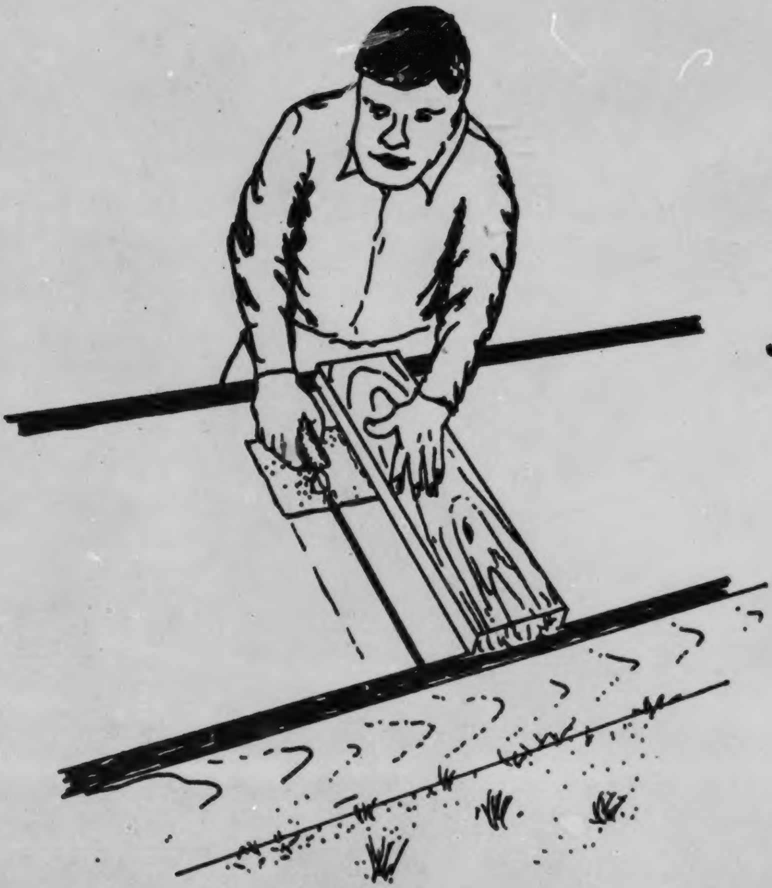


EDGING and JOINTING

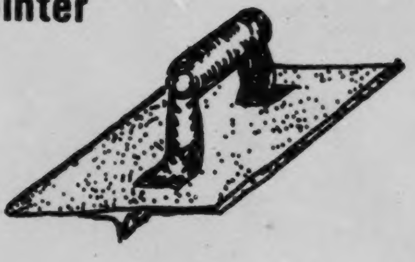


Edger





Jointer



TYPES of FINISH

TYPE	USE	OBTAINED BY
Gritty, non-slipping	Walks, dairy barn floors, etc.	Using wood float
Coarse, scored	Driveways, feeding floors, ramps	Using stiff broom
Smooth finish	Table tops, feed troughs	Using steel trowel
Pea grain	Porches, walks, patios	Washing with water hose

GENERAL CURING REQUIREMENTS

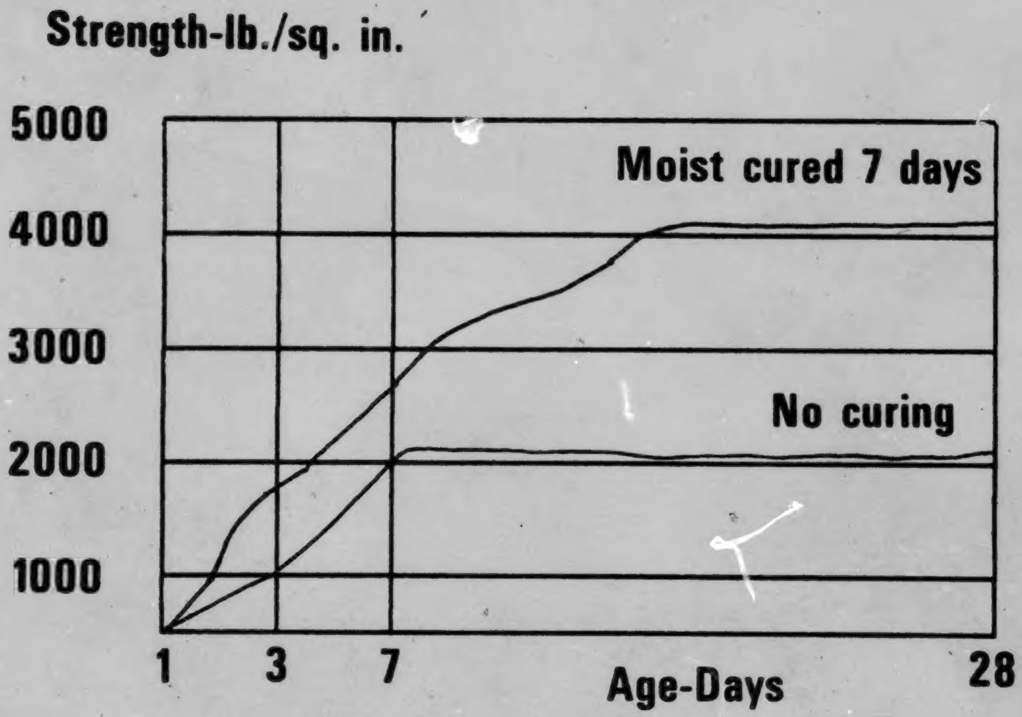
TIME: 3 to 7 Days Minimum

TEMPERATURE: 70° or above for 3 Days

50° or above for 5 Days

DO NOT ALLOW NEW CONCRETE TO FREEZE!!!

EFFECTS of CURING



THE LONGER CONCRETE IS MOIST CURED
THE GREATER ITS STRENGTH

701

PLACING, FINISHING AND CURING CONCRETE
UNIT XIII

TEST

1. Match the terms with the proper definitions.

    1. ______ Crazing
    2. ______ Curing
    3. ______ Edging
    4. ______ Screeding
    5. ______ Floating
    6. ______ Dusting
    7. ______ Scaling
    8. ______ Jointer

    A. Removing the excessive concrete from the forms.

    B. Rounding the edges to prevent chipping or damage to the edge of the concrete.

    C. Pushing the larger aggregates down away from the surface and bringing mortar to the surface.

    D. Plenty of moisture is present to obtain maximum hydration of the cement.

    E. When surface breaks away from the slab.

    F. Fine hair cracks on surface of concrete.

    G. Powdery material on surface of concrete.

    H. To create a groove across concrete to control cracking.

2. Name five of the procedures used in properly placing concrete.

    a.

    b.

    c.

    d.

    e.

3. Name five procedures that are used in finishing concrete.

    a.

    b.

    c.

    d.

    e.

TEST

4. Name the four types of concrete finishes, their uses and how they are obtained.

TYPES	USES	OBTAINED BY
a.		
b.		
c.		
d.		

5. Name two methods used in properly curing concrete.

a.

b.

6. Name the three factors which proper concrete curing improves.

a.

b.

c.

7. List two common methods of curing concrete.

a.

b.

PLACING, FINISHING AND CURING CONCRETE
UNIT XIII

TEST ANSWERS

1. F 1

   D 2

   B 3

   A 4

   C 5

   G 6

   E 7

   H 8

2. a. Place concrete in forms as soon as possible after mixing.

   b. Place concrete where it is needed.

   c. Place in even layers about 6 to 8 inches deep and tamp well.

   d. In slab construction, start at the point farthest away from you, so the next batch will be placed against it to prevent segregation.

   e. Avoid dumping concrete against side of forms.

   f. Avoid letting the chute or buggy hit the sides of the forms.

   g. Tamp and spade the concrete mixture thoroughly to prevent air pockets.

   h. Work the mixture against the side of the forms so the large aggregates will be forced away from the forms for a smooth surface.

   i. In all cases, procedures should be carried out to prevent water from collecting at the ends and corners of the forms.

3. a. Concrete should be screeded as soon as it has been tamped or spaded in the forms.

   b. Finishing should be delayed until the surface is quite stiff but still workable.

   c. Surface water should be allowed to evaporate.

   d. Dry cement should not be sprinkled on top to remove moisture for finishing purposes, as this material will form a layer that is likely to develop hair-line cracks.

TEST ANSWERS

e. Edging and jointing follow the screeding operation.

f. After the concrete is edged and jointed it should be floated.

g. Trowel the concrete to bring a thick film of cement to the top.

4.

	Type	Use	Obtained By
a.	Gritty non-slipping	Walks, dairy barn floors	Using wood float
b.	Coarse, scored surface	Driveways, lots, ramps, feeding floors	Using a stiff broom
c.	Smooth, troweled finish	Table tops, feed troughs	Using steel trowel
d.	Pea grain	Porches and patios	Washing with water hose

5. a. Curing should be started as early as possible and continued for at least seven days.

b. Moisture curing greatly increases the strength of the concrete.

6. a. Strength

b. Durability

c. Watertightness

7. a. Cover with straw, sand, wet burlap, or canvas as soon as possible without marring surface.

b. Flood the surface and hold the water on the surface with some type of border around the edge of slab.

PLUMBING
UNIT XIV

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify various kinds of pipe or tubing and fittings. The student should also be able to demonstrate proper procedures for fitting various kinds of pipe or tubing. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with plumbing to the correct definitions.
2. Match the various kinds of pipe to the use of each.
3. Identify common pipe fittings.
4. Select from a list reasons for using threading compound.
5. Identify tools used in plumbing.
6. List reasons for using cutting oil.
7. Select from a list common sizes of pipe and copper tubing used in plumbing.
8. Describe how pipe size is determined in relationship to copper tubing.
9. Discuss the differences between pipe, bolt, and copper fitting threads.
10. Demonstrate the ability to:
    a. Cut pipe.
    b. Ream pipe.
    c. Thread pipe.
    d. Join or fit plastic pipe.
    e. Sweat a copper joint.
    f. Cut and flare copper tubing.

PLUMBING
UNIT XIV

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined on the job sheets.

  G. Give test.

II. Student:

  A. Read objectives.

  B. Study information sheet.

  C. Demonstrate the ability to complete the procedures outlined on the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency masters

    1. TM 1--Pipe Fittings

    2. TM 2--Types of Valves

    3. TM 3--Plumbing Tools

    4. TM 4--Plumbing Tools (Continued)

    5. TM 5--Pipe vs Bolt Threads

D. Job sheets

1. Job Sheet #1-Cut Pipe
2. Job Sheet #2-Ream Pipe
3. Job Sheet #3-Thread Pipe
4. Job Sheet #4-Join or Fit Plastic Pipe
5. Job Sheet #5-Sweat a Copper Joint
6. Job Sheet #6-Cut and Flare Copper Tubing

E. Test

F. Answers to test

II. References:

A. Phipps, Lloyd, H.F. McColly, L.L. Scranton, and G.C. Cook. *Farm Mechanics Text and Handbook.* Danville, Illinois: Interstate Printers and Publishers.

B. Jones, M. M. *Shopwork on the Farm.* New York: McGraw-Hill Book Company.

C. *General Shop Guide for Vo-Ag Students.* Montgomery: State of Alabama, State Department of Education, Vocational Division, Agricultural Education Service.

D. *Handy Man's Plumbing and Heating Guide.* New York: Arco Publishing Company, Inc., 1973.

PLUMBING
UNIT XIV

INFORMATION SHEET

I. Terms and definitions

   A. Plumbing--Piping and pipe attachments used to carry water into buildings and to drain away sewage and waste

   B. Soil pipe--Any pipe that receives the discharge of waste water from house fixtures

   C. Fitting--Piece used to join pipe, to provide opening in pipe, and to change the direction of pipe

   D. Trap--Water-sealed bend or chamber in a waste pipe

   E. House drain--Pipe which carries all the sewage from the house

   F. Stack--Soil, waste, or ventilating pipe

   G. Fixture--Appliance connected to the plumbing

   H. Septic tank--Tank which receives all the sewage piped into it and allows the process of sewage treatment to take place

   I. Lateral pipe--Pipe which drains the liquid from the septic tank to the soil

   J. I.D.--Refers to Inside Diameter pipe measurement

   K. O.D.--Refers to Outside Diameter pipe measurement

II. Kinds of pipe and their uses

   A. Black--Used for natural and L.P. gas, oil, and air lines

   B. Galvanized--Used for water lines

   C. Copper tubing--Used for water, refrigeration, and waste systems

   D. Cast iron--Used in sewage systems

   E. Brass or lead--Used for traps and drains

   F. Plastic--Used in water systems

   G. PVC--Plastic pipe used in a water or sewage system

   H. Soil--Used in sewage system; generally a cast iron pipe

INFORMATION SHEET

III. Pipe fittings (Transparencies 1 and 2)

   A. 45° elbow

   B. 90° street elbow

   C. Bell reducer

   D. Coupling

   E. Nipple

   F. Tee

   G. Union

   H. Bushing

   I. Cap

   J. Plug

   K. Floor flange

   L. Straight cross

   M. "Y"

   N. Globe valve

   O. Gate valve

   P. Gas stop

IV. Reasons for using threading compound

   A. Insures tight joints

   B. Prevents threads from rusting

V. Tools used in plumbing (Transparencies 3 and 4)

   A. Die

   B. Bench yolk or chain vise

INFORMATION SHEET

C. Burr reamer

D. Pipe wrench

E. Pipe cutter

F. Hacksaw

G. Tapered triangular file

H. Tubing cutter

I. Flaring tools

VI. Reasons for using cutting oil

A. Allows tools to cut smoother

B. Permits tools to cut easier

C. Lengthens lifetime of tools

D. Removes burrs and cuttings from dies

VII. Common sizes of pipe and copper tubing used in plumbing

A. Pipe

1. 1/4"
2. 1/2"
3. 3/4"
4. 1"
5. 1 1/4"

B. Copper tubing

1. 3/8"
2. 7/16"
3. 1/2"
4. 3/16"
5. 5/8"

INFORMATION SHEET

VIII. Size of pip. vs copper tubing

  A. Pipe size determined by inside diameter

  B. Tubing size determined by outside diameter

  C. Pipe wall generally thicker

IX. Differences between pipe, bolt, and copper fitting threads (Transparency 5)

  A. Pipe

    1. Tapers 1/32" per inch in length

       (NOTE: This insures a tight fit.)

    2. Has standard threads

  B. Bolt

    1. Straight

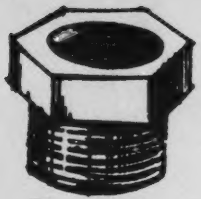
    2. National coarse

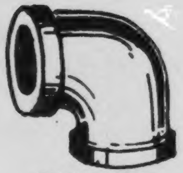
    3. National fine

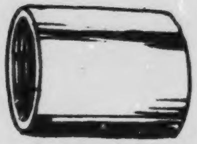
  C. Copper fitting--National fine threads

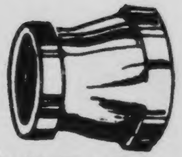
     (NOTE: National fine threads are used to provide more strength to insure a tight joint.)

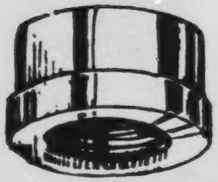
Pipe Fittings

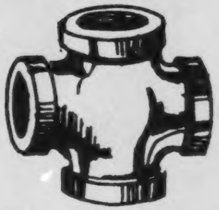

Bushing

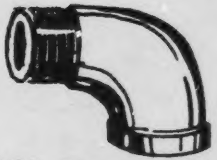

90° Elbow

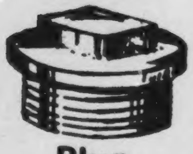

Coupling

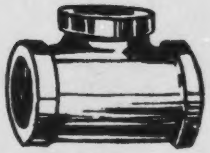

Bell Reducer

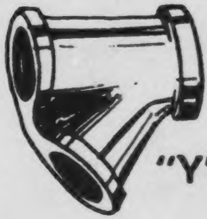

Cap

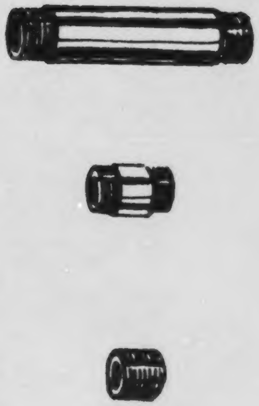

Straight Cross

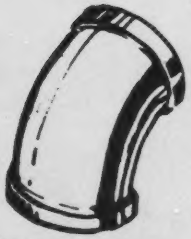

90° Street Elbow

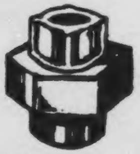

Plug

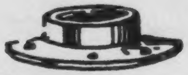

Tee


"Y"

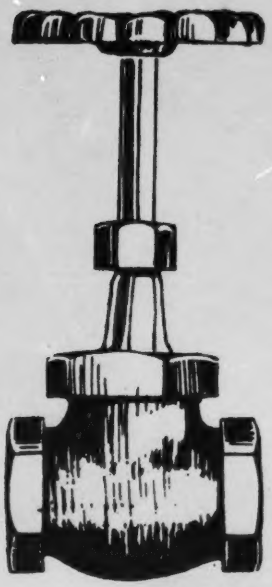

Nipples


45° Elbow

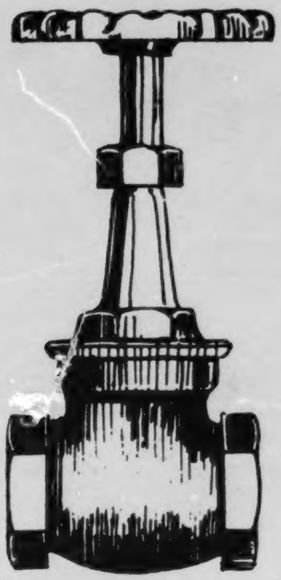

Union


Floor Flange

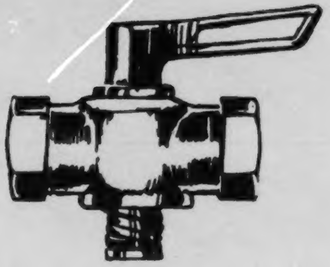
Types of Valves



Globe Valve

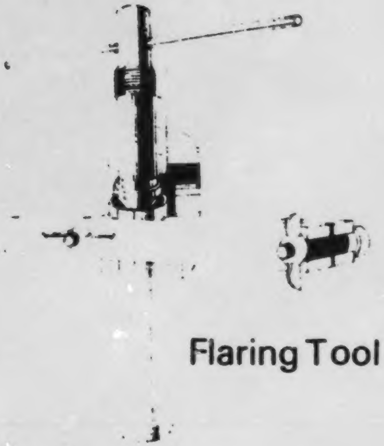


Gate Valve

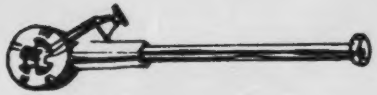


Gas Stop

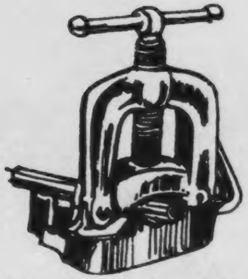
Plumbing Tools



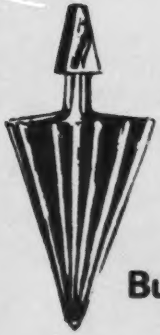
Flaring Tool



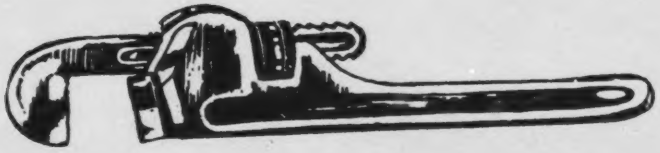
Small Ratchet Threader



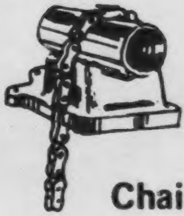
Bench Yoke Vise



Burr Reamer

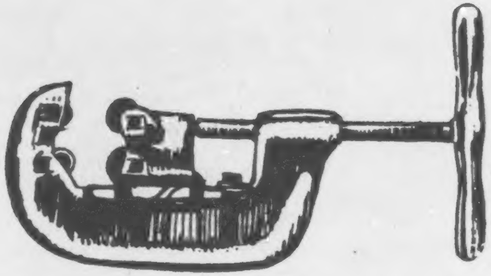


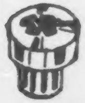
Pipe Wrench

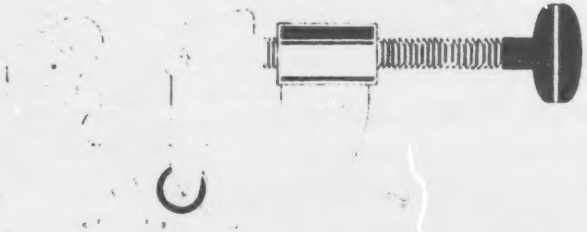


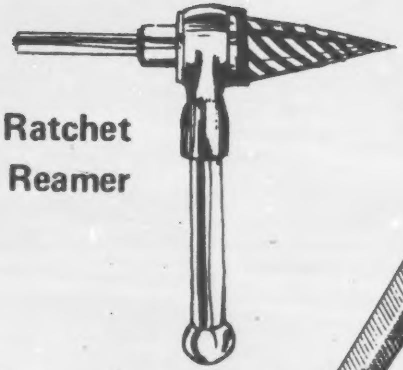
Chain Vise

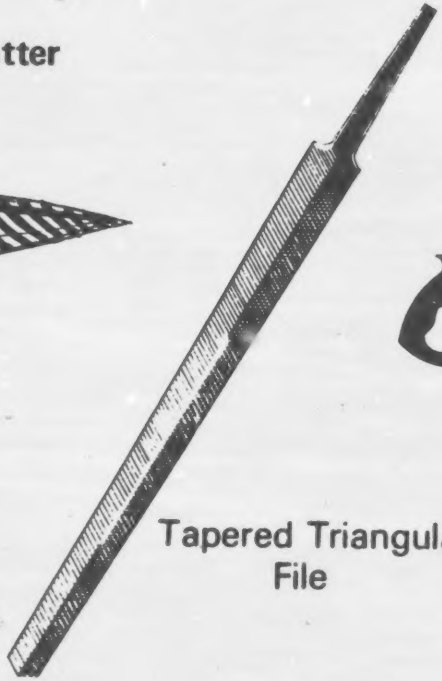
Plumbing Tools
(Continued)


Pipe Cutter


Die

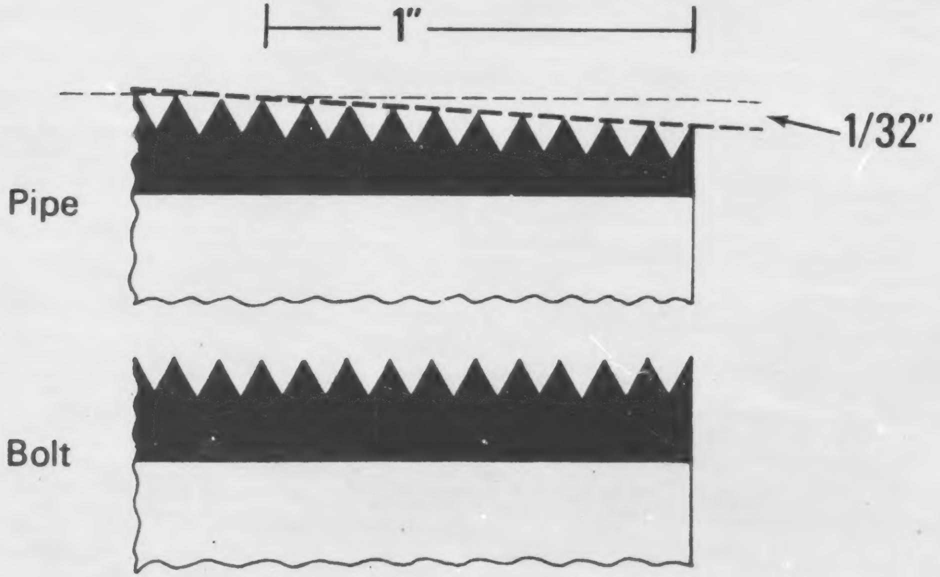

Tubing Cutter


Spiral Ratchet Pipe Reamer


Tapered Triangular File

Hack Saw

Pipe vs Bolt Threads


1"
1/32"
Pipe
Bolt

PLUMBING
UNIT XIV

JOB SHEET #1--CUT PIPE

I. Tools and materials

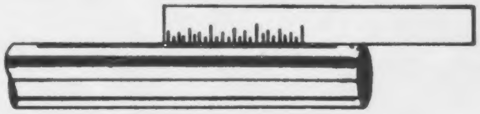
- A. Vise
- B. Tapered triangular file
- C. Ruler or steel tape
- D. Pipe cutter
- E. 3/4 inch pipe, 2 feet
- F. 1/2 inch pipe, 1 foot

II. Procedure

(NOTE: Using the procedure below, cut two pieces of 3/4 inch pipe eight inches long. Cut one piece of 1/2 inch pipe eight inches long, 1/2 inch refers to the inside measurement of the pipe.)

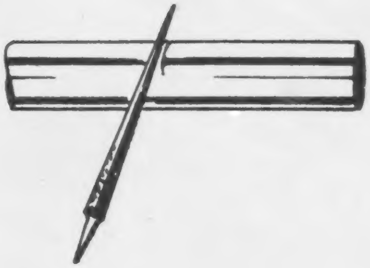
A. Measure length of pipe desired (Figure 1)

FIGURE 1



B. Mark desired length with tapered triangular file (Figure 2)

FIGURE 2



C. Fasten pipe in vise so mark is at least four inches from vise

D. Place pipe cutter on mark

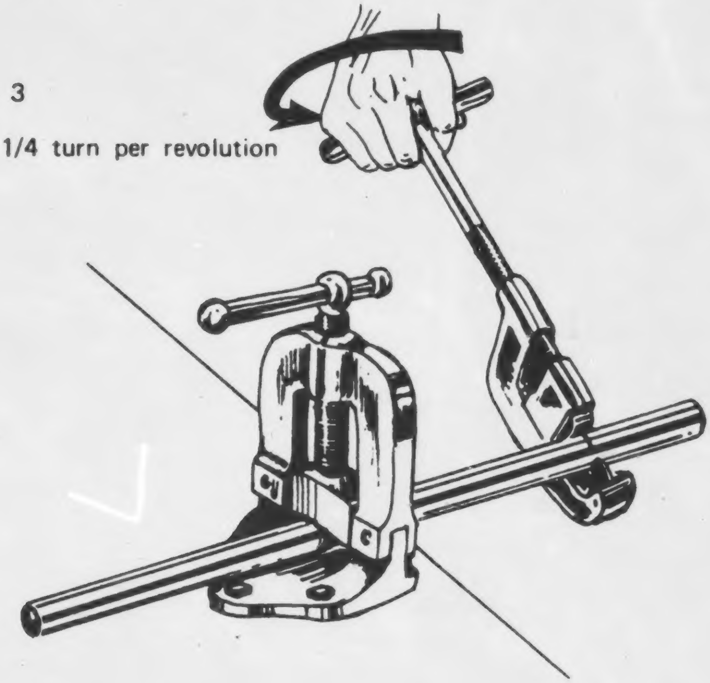
JOB SHEET #1

E. Tighten pipe cutter by screwing in handle until cutting wheel is snug against pipe

F. Hold handle perpendicular to the pipe and tighten handle until cutting wheel penetrates metal

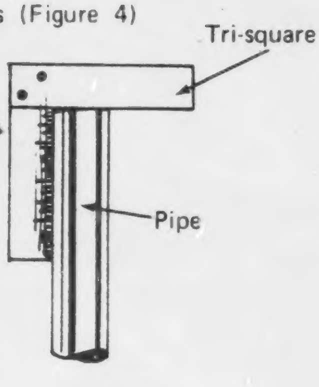
G. Turn pipe cutter 1/4 turn per revolution until pipe is cut off (Figure 3)

FIGURE 3



H. Check cut for squareness (Figure 4)

FIGURE 4



I. Turn in to instructor for grade

PLUMBING
UNIT XIV

JOB SHEET #2--REAM PIPE

I. Tools and materials

  A. Vise

  B. Burr reamer

  C. Carpenter brace

  D. 3/4 inch pipe, 8 inches long, 2 pieces

  E. 1/2 inch pipe, 8 inches long, 1 piece

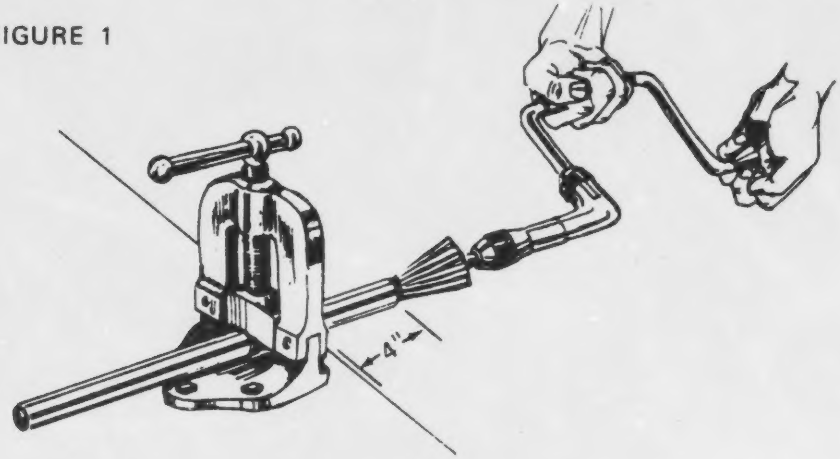
  (NOTE: Use the pipe cut in Job Sheet #1.)

II. Procedure

(NOTE: Using the procedure below, ream two pieces of 3/4 inch pipe eight inches long. Ream one piece of 1/2 inch pipe eight inches long.)

  A. Fasten pipe in vise allowing four inches to extend from vise (Figure 1)

FIGURE 1



  B. Place reamer in line with pipe (Figure 1)

  C. Turn reamer clockwise until inside burr is off (Figure 1)

  D. Remove reamer and check with finger to see if burr is cut away

  (NOTE: Do not cut more than necessary because the first threads on pipe will be weakened.)

  E. Turn in to instructor for grade

PLUMBING
UNIT XIV

JOB SHEET #3--THREAD PIPE

I. Tools and materials

A. Vise

B. Flat file

C. 3/4" and 1/2" dies

D. Die stock

E. Cutting oil

F. Wire brush

G. 3/4 inch pipe, 8 inches long, 2 pieces

H. 1/2 inch pipe, 8 inches long, 1 piece

(NOTE: Use the pipe cut in Job Sheet #1.)

II. Procedure

(NOTE: Using the procedure below, thread the pieces of pipe that were used in Job Sheets #1 and #2. Thread pipes on both ends.)

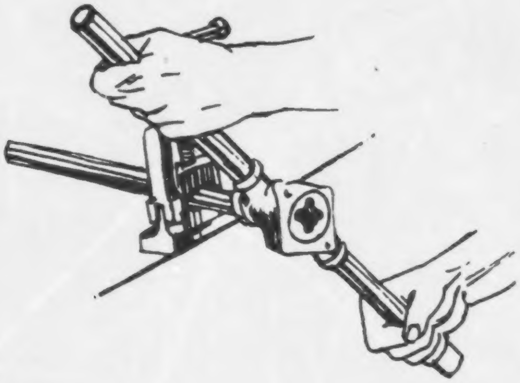
A. Place pipe in vise, allowing six inches to extend from vise

B. File off any outside burr that may be on pipe end

C. Place proper size die in stock

D. Place pressure against die holder with palm of hand; turn clockwise until die starts cutting threads (Figure 1)

FIGURE 1



JOB SHEET #3

E. Use cutting oil on the threading area at all times

F. Continue threading until one thread is past the die

G. Back off die and inspect threads

H. Use wire brush and clean threads

I. Turn in to instructor for grade

PLUMBING
UNIT XIV

JOB SHEET #4--JOIN OR FIT PLASTIC PIPE

I. Tools and materials

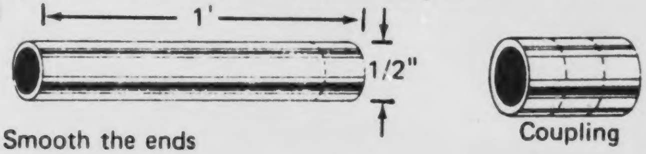
- A. Hacksaw
- B. 1/2" plastic pipe, 2 feet
- C. Plastic pipe cement
- D. 1/2" plastic coupling
- E. Clean rags
- F. Solvent for cleaning plastic pipe

II. Procedure

- A. Cut two pieces of 1/2" plastic pipe one foot in length (Figure 1)

  (NOTE: Make sure ends are cut square.)

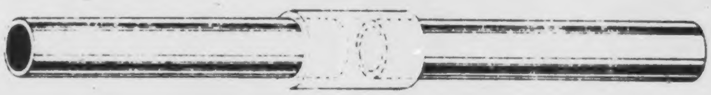
FIGURE 1



- B. Smooth the ends
- C. Clean ends of pipe and coupling with clean rag and solvent
- D. Spread cement evenly over inside of coupling
- E. Insert pipe and give 1/4 turn

  (NOTE: Make sure the pipe is pushed into the coupling as far as it will go. See Figure 2.)

FIGURE 2



- F. Repeat steps C, D, and E for other end of coupling
- G. Let set until dry

PLUMBING
UNIT XIV

JOB SHEET NO. 5--SWEAT A COPPER JOINT

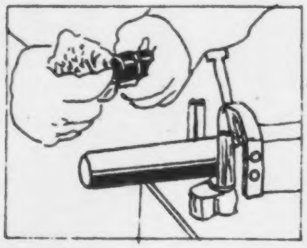
I. Tools and materials

- A. 1/2" copper tubing, 2 pieces
- B. 1/2" copper tubing coupling sweat joint
- C. Solder
- D. Flux
- E. Oxyacetylene torch
- F. Tubing cutter
- G. Reaming tool
- H. Clean rags

II. Procedure

- A. Cut tubing to desired length
- B. Remove burrs, inside and out (Figure 1)

FIGURE 1

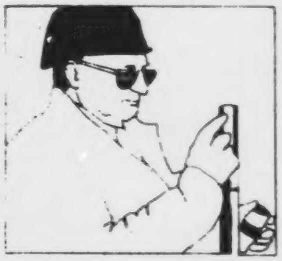


- C. Clean the surface to be soldered by the use of an abrasive material and then coating with flux and wiping clean

JOB SHEET #5

D. Apply a thin, even coat of flux (Figure 2)

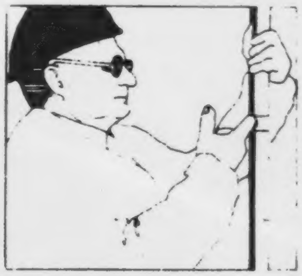
FIGURE 2



E. Join tubing and fitting; give a 1/4 twist (Figure 3)

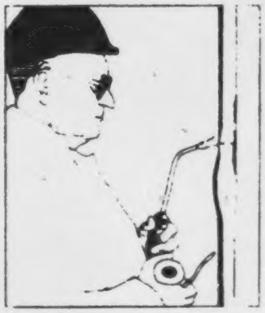
(NOTE: This will spread the flux.)

FIGURE 3



F. Apply heat to the heaviest part of the fitting first then move to the opening where solder enters (Figure 4)

FIGURE 4

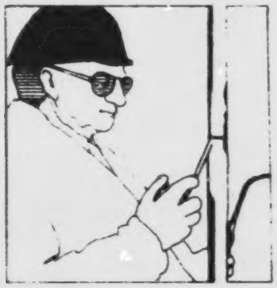


JOB SHEET #5

G. Apply solder to joint (Figure 5)

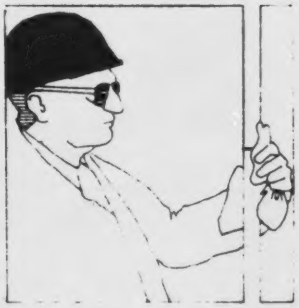
(NOTE: Heat melts the solder and capillary action draws it into the clearance spacer of the joint.)

FIGURE 5



H. Wipe joint clean while solder is molten (Figure 6)

FIGURE 6



PLUMBING
UNIT XIV

JOB SHEET #6--CUT AND FLARE COPPER TUBING

I. Tools and materials

   A. 3/8" flare nuts, 2

   B. 3" copper union, 1

   C. 3/8" copper tubing, 6" long, 2 pieces

   D. Tubing cutter

   E. Flaring tool

   F. Reamer

   G. File

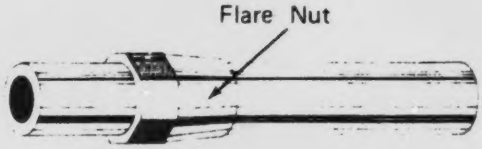
II. Procedure

   A. Cut tubing to desired length

   B. Remove burrs, inside and out

   C. Place flare nut on tubing (Figure 1)

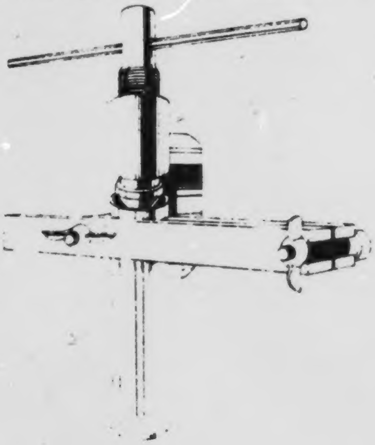
FIGURE 1



   D. Place tubing in flaring tool and secure (Figure 2)

   (NOTE: End of tubing should be flush with flaring tool.)

FIGURE 2



JOB SHEET #6

E. Flare end of tubing

(NOTE: Make sure end flares evenly and will fit the union snugly.)

PLUMBING
UNIT XIV

TEST

1. Match terms associated with plumbing to the correct definition.

______ a. Pipe which drains the liquid from the septic tank to the soil

______ b. Pipe which carries all the sewage from the house

______ c. Water-sealed bend or chamber in a waste pipe

______ d. Soil, waste, or ventilating pipe

______ e. Piping and pipe attachments used to carry water into buildings and to drain away sewage and waste

______ f. Piece used to join pipe, to provide opening in pipe, and to change the direction of pipe

______ g. Appliance connected to the plumbing

______ h. Any pipe that receives the discharge of waste water from house fixtures

______ i. Tank which receives all the sewage piped into it and allows the process of sewage treatment to take place

______ j. Outside diameter of pipe

______ k. Inside diameter of pipe

1. House drain
2. Stack
3. Fixture
4. Septic tank
5. Lateral pipe
6. Plumbing
7. Soil pipe
8. Fitting
9. Trap
10. O.D.
11. I.D.

2. Match the various kinds of pipe on the right to the correct use.

______ a. Used for water lines

______ b. Used for natural and L.P. gas, oil, and air lines

______ c. Plastic pipe used in a water or sewage system

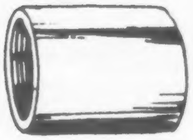
______ d. Used in sewage system; generally a cast iron pipe

______ e. Used for traps and drains

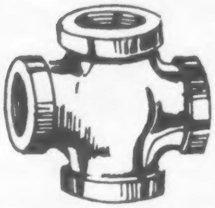
______ f. Used for water, refrigeration, and waste systems

1. PVC
2. Black
3. Soil
4. Galvanized
5. Brass or lead
6. Copper tubing

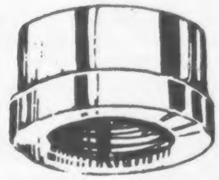
3. Identify the following common pipe fittings by writing the correct name in the blank.



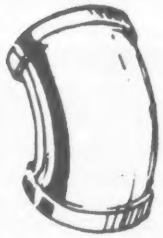
a. ____________



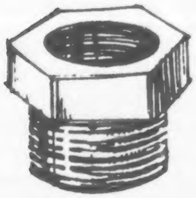
b. ____________



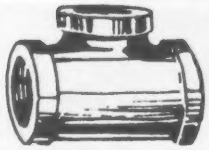
c. ____________



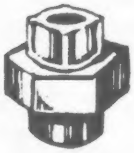
d. ____________



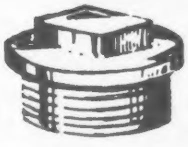
e. ____________



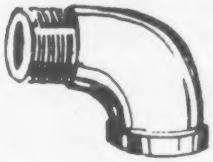
f. ____________



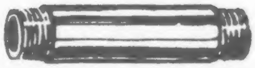
g. ____________



h. ____________



i. ____________



j. ____________

4. Select from the list below reasons for using threading compound by placing an "X" in the blank.

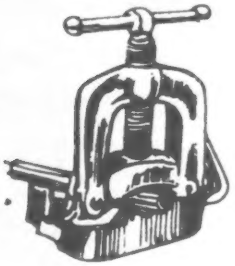
______a. Insures tight joints

______b. Fits together easier

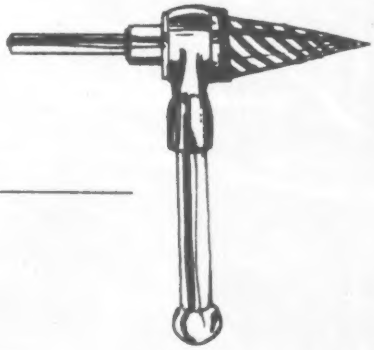
______c. Prevents threads from rusting

______d. Can be disassembled easier

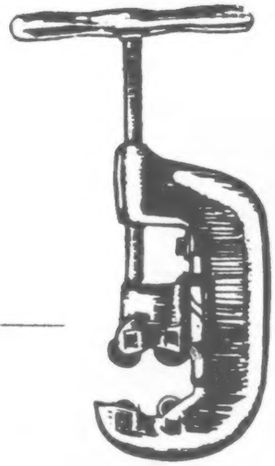
5. Identify the following tools used in plumbing by writing the correct name in the blank.



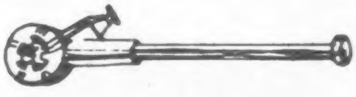
a. ______________



b. ______________

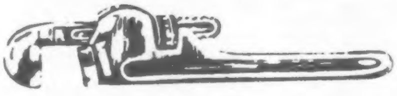


c. ______________



d. ______________

e. ______________



6. List four reasons for using cutting oil.

a.

b.

c.

d.

7. Select from the list below common sizes of pipe and copper tubing used in plumbing by placing an "X" in the blank.

Pipe	Copper tubing
_____a. 4"	_____h. 2"
_____b. 1"	_____i. 3/8"
_____c. 1 1/4"	_____j. 1/2"
_____d. 1/2"	_____k. 7/16"
_____e. 3"	_____l. 1"
_____f. 2"	_____m. 1 1/4"
_____g. 3/4"	_____n. 1 1/2"

8. Describe how pipe size is determined in relationship to copper tubing.

9. Discuss the differences between pipe, bolt, and copper fitting threads.

10. Demonstrate the ability to:

    a. Cut pipe.

    b. Ream pipe.

    c. Thread pipe.

    d. Join or fit plastic pipe.

    e. Sweat a copper joint.

    f. Cut and flare copper tubing.

    (NOTE: If these have not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

PLUMBING
UNIT XIV

ANSWERS TO TEST

1. a. 5
   b. 1
   c. 9
   d. 2
   e. 6
   f. 8
   g. 3
   h. 7
   i. 4
   j. 10
   k. 11

2. a. 4
   b. 2
   c. 1
   d. 3
   e. 5
   f. 6

3. a. Coupling
   b. Straight cross
   c. Cap
   d. 45° elbow
   e. Bushing
   f. Tee
   g. Union
   h. Plug
   i. Street elbow
   j. Nipple

4. a, c

5. a. Bench yoke vise
   b. Spiral ratchet pipe reamer
   c. Pipe cutter
   d. Ratchet threader
   e. Pipe wrench

6. a. Allows tools to cut smoother
   b. Permits tools to cut easier
   c. Lengthens lifetime of tools
   d. Removes burrs and cuttings from dies

7. b, c, d, g, i, j, k
8. Description should include:
   - a. Pipe size determined by inside diameter
   - b. Tubing size determined by outside diameter
   - c. Pipe wall generally thicker
9. Discussion should include:
   - a. Pipe
     1. Tapers 1/32" per inch in length
     2. Has standard threads
   - b. Bolt
     1. Straight
     2. National coarse
     3. National fine
   - c. Copper fitting--National fine threads
10. Performance skills evaluated to satisfaction of the instructor.